Where the money flows? Colonial health investment and hospital outcomes in the D.R.Congo

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Abstract

This paper explores the role of colonial medical missions in causing contemporaneous disparities in hospital outcomes in the Democratic Republic of Congo. Using digitised archival records from colonial Belgian Congo between 1929 and 1959, we track the establishment of colonial health settlements and match them with contemporaneous hospitals. The study leverages variation in historical origin of hospitals driven by the prevalence of sleeping sickness during the colonial period. The disease, now classified as neglected tropical disease, is shown to be unrelated to prior economic, social and epidemiological determinants of colonial activities. We first document a strong, positive, and persistent effect on physical infrastructure. The ability of the colonial regime to mobilise large health investments and skilled resources appears to be a strong channel of persistence of the colonial effects. Second, we find that hospitals with colonial origins receive considerably more resources from the central government today, even after controlling for differences in hospital ownership, staffing, and bed capacity. We argue and provide evidence that in the aftermath of independence, colonial hospitals were more likely financially supported by external assistance which enhanced their bargaining power with the government for attracting public funds. This advantage may continue to shape disparities in the financing of hospitals in the present day.

JEL classification: H41; H51; I15; I18; N37.

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1 Introduction

Persistent inequalities in development and investment in health infrastructures are hampering health system performance in Sub-Saharan Africa (SSA) (Hsia et al., 2011). This fact is particularly salient in the hospital sector which absorbs more than half of total health domestic expenditures (WHO, 2014). Most SSA countries have long suffered from chronic levels of underinvestment in healthcare, leaving the health infrastructure unevenly distributed, and with unequal access to sanitation, electricity, or public transport. These inequalities have direct consequences on both the technical and allocative efficiencies of hospitals, the distribution and shortage of health workers (Sheffel et al., 2024), and ultimately access to health care (Ouma et al., 2018; Oleribe et al., 2019). What accounts for these disparities? Although reforms and structural changes in the recent past contributed to shaping the present-day health sector in Africa, some inequalities in the development path of health institutions may be more deeply rooted in the colonial past of SSA. European colonial powers established extractive institutions with long-run consequences on economic growth (Acemoglu et al., 2001). They were also the first to establish modern health systems, public health financing, national-wide public health policies, and the organisation of health care, in a way that may continue to determine the financing and provision of health care.

This paper attempts to bring a new perspective on this issue by investigating the historical legacy of the colonial regime in Belgian Congo on modern disparities in the hospital sector. In 1908, Belgium took over Congo, previously ruled by King Leopold II of Belgium in the late nineteenth century, to address international critiques of the atrocities within the rubber concessions. The following year, the Department of Health was created within the Ministry of Colonies to coordinate the colonial medical organisation, improve access to health care, and develop preventive and curative medicine. The institutionalisation of health care was reinforced by increasing public health investments, essentially to support the fight against epidemic diseases, primarily sleeping sickness (Lyons, 2002). After World War II, an intensive ten-year public investment plan considerably expanded the provision of health care in the colony, that almost triple the number of beds per 1,000 and double the number of physicians. On the eve of independence in 1960, Congo had one of the most developed medical infrastructures in Africa (Pepin, 2011).

We empirically examine whether and to what extent colonial health investments may have a causal effect on contemporary hospital public financing and output production. To do so, we mobilise archival data on public finances and medical services in the Belgian Congo between 1926 and 1959, along with contemporary data on the Democratic Republic of Congo (DRC). We construct a novel geocoded dataset of colonial health facilities by exploiting historical maps from the Ministry of Colonies of the Belgian Congo that document the location of health infrastructures supported by religious, private, and colonial government funds.[1] Each colonial health infrastructure is then matched with a contemporaneous hospital

[1]While many recent studies on legacies of religious missions in the past have exploited data from historical atlases,

by using a unique database of epidemiological and financial information on modern health facilities between January 2017 and December 2021, collected from the Health Information Management System of the Ministry of Health of the DRC.

We estimate the causal effect of colonial investments on modern health facility outcomes by using different strategies. We start with estimating an Ordinary least squares (OLS) model that controls for a large set of historical, geographical, epidemiological and demographical covariates at the hospital level. We confirm the robustness of the results to alternative structures of the error term, show that they are unlikely driven by omitted variable bias, and rule out confounding effects of the distribution of health workers across hospitals. Next, we employ nonparametric matching estimations between colonial and post-colonial hospitals based on their geographic locations, and a wide range of hospital characteristics, and confirm the results with entropy balancing, that reweights observations to ensure balance in hospital characteristics (Hainmueller, 2012). Finally, we address the potential endogeneity of mission settlements (Jedwab et al., 2022) by instrumenting colonial health settlements with the prevalence of sleeping sickness during the colonial period.[2] While colonial activities affected the delicate ecological equilibrium between men, tsetse flies and wildlife, they did not directly cause the outbreak of the disease nor its spatial propagation (Ford, 1971) which was largely unpredictable for the colonial health authorities (Lyons, 2002). Following colonial health reports that repeatedly highlight the importance of fighting the spread of sleeping sickness and reducing its burden, we show that the disease strongly predicts colonial medical expansion. Although sleeping sickness was endemic in the Congo during the colonial era, its modern health burden has become negligible in recent times, particularly with regard to other diseases such as malaria. We also document that the historical habitat of the tsetse fly, which contributed to transmitting the sleeping sickness, significantly differs from the breeding sites of mosquitoes which are currently responsible for the prevalence of malaria, the highest disease burden in the country. We further demonstrate that the colonial disease was unrelated to prior economic, social and epidemiological determinants of colonial activities. Moreover, we argue that exploiting maps on the distribution of sleeping sickness at multiple periods during the colonial period should account for colonial expansion and reduce the concern that the quality of measurement of sleeping sickness simply reflects colonial presence.[3]

Could the historical propagation of the sleeping sickness directly affect modern hospital outcomes? Although we control for an extensive set of historical and geographic variables, additional unobserved

historical archives from the Belgian Congo provide a more accurate and complete source of information, and can overcome the limited capacity of atlases to report mission activities (Jedwab et al., 2022).

[2]We consider sleeping sickness distribution to be the preferred measure for colonial presence over alternative measures. Following Lowes and Montero (2021b), an alternative instrument could use the suitability of the soil for cassava relative to another traditional crop in Belgian Congo such as maize. While the instrument can predict sleeping sickness, it has a low predicting poorer for colonial health settlements. Alsan (2015) created a tsetse fly suitability index in Africa, but colonial health authorities in Congo already provided fine grained data on the geographic distribution of tsetse flies, and reported little variations across the country (Online Appendix Figure A20).

[3]Our assumption posits that areas with high sleeping sickness and low colonial presence were not systematically under-reported by colonial authorities. This assumption is likely valid since during the colonial period, colonial health authorities extended their presence in most parts of the country through mobile health units to identify, and treat cases of sleeping sickness (Lyons, 2002). By the end of the colonial era, the burden of the disease was considerably reduced (Ekwanzala et al., 1996)

factors could affect both the colonial disease and modern health facilities. When examining hospitals built after independence in areas with high rates of sleeping sickness during the colonial period, the instrument loses its predictive power on modern hospital outcomes. This result bolsters our confidence that the instrument is operating only through colonial health settlements.

What determined the size of initial health endowments? Using bed capacity as a proxy for colonial health investments, our results show that, at the intensive margin, investments were mostly driven by population density during the last decade of the colonial era. The presence of European populations, whose healthcare was largely funded by the colonial regime (Duren, 1953), does not predict colonial health investments.

To examine any persistence in the contemporaneous allocation of public health resources across health facilities, we collect data on government transfers to hospitals. Government transfers are essentially allocated from the central government to finance the salary of health staff (World Bank, 2021). After accounting for the number of nurses, physicians, population catchment area, hospital ownership (public, faith-based, and private) and geographic factors, we document that health facilities built during the colonial period have larger infrastructures and receive significantly more subsidies from the central government than post-independence facilities. We further demonstrate that the colonial effect on government transfers is not merely driven by the difference in the size of colonial hospitals, as the effects remain significant even when accounting for physical infrastructure. On the other hand, health care provision remains largely unaffected by the historical origin: colonial hospitals are not characterised by higher numbers of total and disease-specific outpatient visits once accounting for health staff. Results are highly robust to a wide range of alternative specifications, groups of hospitals, and estimation strategies.

One could be concerned with the risk of "compression" of history with findings on persistent colonial effects, that would ignore critical periods associated with major structural changes in the political and economic landscapes (Austin, 2008). To address this concern, we build the first long-run series of public financing and public health budget in the DRC. We hypothesise that higher initial endowments in public healthcare infrastructure during the colonial period than after the independence of the Congo may have contributed to building a network of health facilities with comparatively higher physical and human capital than health facilities built at later stages. Drawing from colonial archives of public finance, and reports mostly from International Monetary Fund (IMF) and International Bank for Reconstruction and Development (IBRD) in the post-colonial period, we show that the post-colonial period is characterised by a structural change in both the capacity and willingness of the government to finance the health care sector. The evidence supports our view that hospitals built during the colonial period benefited from comparatively higher investment levels with long-lasting effects on the bed capacity of modern structures. The first three decades under the Mobutu regime were marked by a general increase in public expenditures that were mostly earmarked for the salary payment of some selected administrative posts (Garrett, 2003). The increased elite capture of the public funds in the post-colonial period largely contributed to impoverishing the health sector and the general Congolese economy (Bension et al., 1980).

The colonial enterprise instituted a two-tiered health care system segregating 'white Europeans', entitled to a high quality of health care, and Congolese 'black' populations for whom health financing mostly served to maintain labour productivity at its desired level (Kivilu, 1984). We do not continue to observe significant differences in government transfers or the size of infrastructure between these two types of colonial hospitals. We further document that the timing of the first colonial health settlement, and the historical source of the colonial funding (government, religious, or private) do not play a role in the colonial effect on modern hospital outcomes. On the other hand, we show that modern hospital ownership matters: private hospitals with a colonial past are significantly larger but receive less government support in the form of salary paid to the health staff. After independence, many health institutions struggled to remain operational following the departure of private investors and a large share of religious missionaries, combined with the collapse of public health budget. This assumption is supported by the sharp reduction in the number of private-owned hospitals (78%) recorded in the colonial archives that either changed ownership (mostly to public) after independence or no longer exists in the modern list of hospitals.[4] Meanwhile, larger colonial hospitals may have more likely attracted private investments for their opportunity costs: large hospitals with high initial sunk investments in buildings during the colonial period might have yielded higher flow of services over a number of years, and despite capital depreciation, may have been less expensive at the margin to maintain because of economies of scale (Giancotti et al., 2017).[5]

Our analysis on the channels of persistence rules out any mediating role of economic development, ethnicity, contemporaneous disease burdens, modern conflict, or local elite capture. We further show that quality of care does not systematically differ across hospitals, and exclude thereby the possibility that the central government strategically targets better working hospitals. Instead, we argue and provide suggestive evidence that hospitals originating from colonial settlements may have historically established closer ties with the central government than post-independence facilities through financial support from Western donors. Our results show that Western donors' support for hospitals and proximity to local aid projects increase for health structures with a colonial origin. On the contrary, Chinese aid, which has been shown to be less tied to restrictions (Dreher et al., 2019), is more likely to be closer to postcolonial hospitals. For international donors in the aftermath of independence, the decision to build a new health facility or financially support an existing colonial hospital depended on the opportunity costs. As the colonial regime already expanded the health infrastructure in most rural areas of the country, donors' projects may have been more likely targeting existing health structures to achieve their health and development objectives. In turn, the lobbying activities of colonial hospitals with the government to compete for limited state resources may have grown stronger over the postcolonial period once they benefited from the support of external aid (Hearn, 1998). As a complementary channel, our evidence shows that the central government may also overestimate the transfers needed to larger hospitals, which

[4] Only 6% of modern hospitals with a colonial origin belong to the private sector.

[5] Hospitals with very large sizes (more than 600 beds) may have increased managerial costs, and higher costs related to the depreciation of capital (Giancotti et al., 2017), but we do not have such hospitals in our sample.

tend to have a colonial origin. This result may reflect a government bias towards more conspicuous health structures, and the willingness to incentivise their health workers.

This study relates to several strands of existing research. First, we contribute to the literature on the historical roots of modern medicine. A growing number of studies single out the extractive nature of colonial missions in durably affecting health behaviour and mistrust in medicine. The Belgian Congo is an illustrative example where labour coercion and constant use of violence for resource extraction disrupted both local communities and the Congolese society (Kivilu, 1984; Lyons, 2002). Lowes and Montero (2021b) study the effect of medical campaigns in French Central Africa, where villagers were forced to receive injections of medications, and find a significant reduction in modern health outcomes and trust in medicine. Lowes and Montero (2021a) show that the extreme brutality employed within rubber concessions during the early colonisation of Congo continue to negatively affect the present day health outcomes of individuals living in those exposed areas. Additional studies document the adverse effect of colonial legacy on modern HIV burden (Cagé and Rueda, 2020; Anderson, 2018) and its role on the modern disparities of the disease (Denton-Schneider, 2024). On the other hand, the proximity to religious medical missions during the colonial era is also shown to strongly predict contemporaneous better health outcomes (Calvi and Mantovanelli, 2018). Our study demonstrates that the presence of colonial settlements could have contributed to creating a two-tier healthcare system through differential physical infrastructure, and durably affected the allocation of public resources across health care providers. While postcolonial hospitals could have arguably been favoured by the government as more representative of the new independent postcolonial identity, our findings rather suggest that states built their health systems from what they inherited from colonial rule. The ability of colonial regimes to mobilise large health investments and skilled resources, although driven by resource exploitation, appears to be a strong channel of persistence of the colonial effects. This finding is consistent with Huillery (2009) who documents a positive effect of colonial investments in health, education and infrastructure on the current performance of each of these public goods. Second, our work adds to the literature on the persistent effect of colonial investments in infrastructure (Huillery, 2009; Bleakley and Lin, 2012; Jedwab and Moradi, 2016; Jedwab et al., 2017; Donaldson, 2018; Mitrunen, 2024). The importance of initial factor endowments echoes the results in Jedwab et al. (2017) on the role of colonial sunk investments as a channel of persistence. We maintain that in the postcolonial period, the reduced fiscal capacity of the new states may have decreased the capacity of newly built healthcare facilities. As poverty and global health burdens increased and foreign aid started to pour in, donors may have favoured the existing network of colonial health institutions that could deliver comparatively higher services, thereby contributing to maintaining a two-tier financing system of health institutions with different development paths.

More broadly, this study relates to the literature on long-run persistence of colonialism on economic development and institutions (Sokoloff and Engerman, 2000; Acemoglu et al., 2001; Dell, 2010; Nunn, 2014).[6] Scholars have shown the importance of initial conditions and factor endowments on modern

[6]For a thorough review of this literature, see Michalopoulos and Papaioannou (2020).

institutional and economic development. Although former colonial areas may also be characterised by lower investment in human and physical capital in the post-colonial period (Iyer, 2010), colonial investments in public goods could also lead to positive effects on human capital (Huillery, 2009; Wantchekon et al., 2015). Dell and Olken (2019) show that extractive institutions could result in comparatively higher economic and social outcomes in the long run. We show that colonial investments continue to have an important role on the allocation of public health resources, but which may not in turn affect the quality of health care provision. The paper suggests that coordination around existing investments could be an important channel of persistence, even in the presence of historical extractive institutions.

The focus on the Belgian Congo provides an opportunity to examine the effect of a colonial regime covering a vast spatial territory, beyond the comparatively more studied French and British colonial rules. Furthermore, no studies have, to our knowledge, explored the effects of colonialism on modern hospital outcomes. Our novel dataset allows us to estimate directly the persistence of colonial effects at the granular level and avoid losing information through data aggregation.

The roadmap of the paper is as follows. Section 2 provides a historical background on the DRC and its health system. Section 4 describes the data and the geographical analysis. Section 3 introduces the conceptual framework. Section 5 presents the long-run effects of colonial legacy. Section 6 explores multiple alternative channels for the results, and Section 7 concludes.

2 Background

We provide in this section the necessary historical background of Congo to examine how colonisation and post-independence events may have shaped the development path of health institutions and determined the financing structure of the modern health system. Additional details are provided in Online Appendix Section A.

2.1 Colonial legacy of public health

The colonisation of Congo began in 1885 with the Congo Free State, infamous for its brutality against native populations. The private colony governed by the King Leopold II of Belgium, became the Belgian Congo in 1908 when the Belgian state took over the control of the vast territory. The former colonial regime had an economic and administrative structure primarily oriented toward the extraction and exportation of mineral resources (copper, diamond, gold, rubber) and crops (cotton, palm oil) through human exploitation and shaped the Congolese institutions to serve an export-oriented economy (Nest et al., 2006). The first medical campaigns in the Congo appeared in the early twentieth century with the outbreak of sleeping sickness, or human African trypanosomiasis (HAT), a disease transmitted through the bite of the tsetse fly. The country had to wait until the early 1920s to have a healthcare system with substantial public investments and the development of medical missions for the Congolese populations that were supported by the state (Lyons, 2002).[7] The disastrous effect of sleeping sickness on local populations became a major health challenge for the colonial medical authorities during the interwar period. In response to the epidemic, hospitals and health centres were especially built for indigenous populations, mass campaigns of spraying pesticides were conducted and medical missions were launched throughout the country to examine local populations and forcibly administer medical treatment for the disease.

The provision of health care was administered by three coexisting actors: the state, Christian (Protestant and Catholic) missions and private firms. Some independent health organisations partly funded by the government of the Belgian Congo or private companies also took a major role in the provision of health care.[8]

Although all medical care was free of charge, the distribution of health services was highly uneven, with the best and most expensive care restricted to Europeans (Figures A6 and A7 in Online Appendix). On the other hand, the provision of health care for the native Congolese population was rudimentary and primarily geared towards a healthy and productive labour force required for both colonial health and economic concerns (Hunt, 1999). Services were initially located in colonial settlement areas and gradually expanded towards rural areas with the colonial expansion.

In the aftermath of World War II, European colonial rulers shifted their exploitation model of the colonies towards a development approach. The Congolese colony experienced rapid economic growth and used its budget surplus and international borrowing capacity through Belgian support to finance a massive ten-year public investment plan (1949-1959) for the economic and social development of the country (the Van Hood Duren Plan). The investment plan included a health component with 3 billion Belgian Congo Francs (approximately 3% of GDP) aimed to equip all provinces of the Belgian Congo with Medico-Surgical centres (rural hospitals) supported by surrounding dispensaries in remote areas to provide primary care and large, high-tech medical hospitals in urban areas (Duren, 1953). The objective behind the newly created facilities was to create focal points of a large integrated network of satellite dispensaries that would provide health services even to hard-to-reach rural areas. The total number of health facilities (hospitals, dispensaries, maternities, health centres and posts) rose from 568 in 1949 to 2,815 by the end of the colonial period, and comprised 293 General Referral Hospitals, more than 52,000 hospital beds and 703 physicians (MC, 1958). In 1959, with more hospital beds than all the rest of sub-Saharan Africa, the country had one of the most developed medical infrastructures in Africa (Pepin, 2011).

[7] There were 2 doctors in 1896 in the Congo Free State, and 30 by 1908 (Lyons, 2002).

[8] Examples of such health organisations are the *Fondation Médicale de l'Université de Louvain au Congo* (FORMULAC), the *Fondation Reine Elisabeth pour l'Assistance Médicale aux Indigènes* (FOREAMI) or the *Croix-Rouge du Congo.*

2.2 Health system and the state

By the time of independence, most of the Congolese population experienced better health and improved socio-economic conditions compared to the previous generations who witnessed the beginning of the colonial enterprise (Kivilu, 1984; Lyons, 2002).

The flourishing economy of European settlers remained until the Congo gained its independence in July 1960. The complete reliance on external financial, technical, and managerial support brought huge challenges in maintaining the comprehensive preventive and curative health system and the Congolese economy in general. The newly created State immediately entered a period of political upheavals and civil conflicts until Joseph Mobutu took control of the government in 1965 to establish an authoritarian rule of the country (renamed Zaire in 1971) that lasted three decades. While most European skilled workers fled the country following independence and all public services deteriorated, the copper industry resisted the troubling series of events and provided up to 80 percent of Congolese foreign revenue in the 1970s (IBRD, 1973). In the meantime, the absence of public funds inhibited the maintenance and expansion of the Congolese health system. The drastic fall in copper prices starting in 1973 combined with hyperinflation, an enormous debt burden, and the confiscation of foreign private properties by the state (the country's "Zairianization") eventually drove the country into economic collapse (Hesselbein, 2007), reducing further the fiscal space for the public financing of health care and ultimately dragging down government health expenditures (Gardner, 2013).

To prevent the entire collapse of the health system, the international community mobilised financial and human support as early as 1961 along with aid disbursements for economic development (Figure A1 in the Online Appendix). Yet the repeated lack of governmental health financing (Figure 2) hampered any possibilities to restore the provision of health and medical services to their colonial levels, and the effective distribution of medical supplies (Mock et al., 1990). Most vaccination campaigns ceased and the shortage of human and financial resources severely disrupted the control of some of the major endemic diseases (malaria, leprosy, tuberculosis, sleeping sickness) that had been reduced near the end of the colonial period (World Bank, 1987). These changes, combined with widespread poverty and nutritional deficiency, contributed to adversely affecting the post-independence mortality rates.[9] With the continuous deterioration of infrastructure and equipment of health centres, health services became fragmented, with various providers such as religious groups, private dispensaries, and public health centres that operated independently, with their own sources of funding, procurements of drugs, and management procedures.

As the Mobutu regime ended in the late 1990s, wars with Uganda and Rwanda, and the fragmentation of Congo into four autonomous regions precipitated the country to a general state implosion (Nest et al., 2006). The official ceasefire in 2003 and the reunification of the country left a fragile state in economic and political crisis, marked by weak state and institutions, rampant corruption and a

[9] Available data on mortality rates is limited and often inconsistent.

dearth of public investments (Mock et al., 1990). As for most of the public sector, basic salary support to the health staff is frequently missing, and the vast majority of modern health facilities are in dire need of rehabilitation (MSP, 2011). Hospitals have suffered a long decline in their capacity to deliver health services (Figure A11 in Online Appendix) with frequent disruptions in drug supply and health equipment (MSP, 2011).

Health system financing. National health financing is low in the DRC: the share of government spending on health has oscillated around 4% of the total government budget since independence (Figure 2). In this setting, Development Assistance for Health (DAH) grew as a vital source of funding for the current health system. The financing of the Congolese health system highly depends on DAH, which accounts for nearly 40% of total healthcare expenditures (MSP, 2019). The growing share of DAH in the financing of the Congolese health system over the past 30 years (Figure A2 in the Online Appendix) highlights the predominant role of external funding. Due to low government spending, consultation fees are heavily applied in all health facilities (public, private, faith-based) and represent up to 90% of health facility operating costs (MSP, 2019).[10] As a result, private out-of-pocket expenditures constitutes the major funding source of healthcare with about 45% of total healthcare expenditures (MSP, 2019).

The modern health system of the DRC has three levels of organisation. At the central level, the Ministry of Health sets the national health strategies for each of the 26 provinces of the country, and directly manages all General Referral Hospitals. The provincial health departments are responsible for technical and logistical support of the health system at the intermediate level, and the management of (smaller) provincial hospitals, and facilitate the implementation of the national policies. The third level is composed of 516 health zones, the smallest functional units but which are the basic building blocks of the entire health care system. A health zone covers a population between 100,000 and 200,000 and generally consists of a (district, or health zone) general referral hospital (public, faith-based or private), and peripheral health centres and hospitals that provide primary health care services for all cases that can be treated without referral to a hospital.[11]. Figure A3 in Online Appendix tracks the evolution of administrative boundaries in the Congo from the inception of the colonial period to the most recent change in 2015.

Lack of equipment, drug supply, qualified personnel, and salaries is widespread among all health facilities in the country (Brunner et al., 2019). While donors provide free or low-cost health products to some facilities or health zones, as well as technical support, the lack of donor coordination also hampers the effective distribution of health products across the country.

[10] Revenue from user fees are primarily used for medications, medical and non-medical supplies, wages of administrative staff and facility maintenance (ICF, 2020).

[11] However, this organisation is rather theoretical, as district hospitals often compete with other hospitals in primary care provision rather than focusing on referral services (Ntembwa and Van Lerberghe, 2014)

3 Evolution of public finances and health care provision

This section first posits explanations to understand the long-run effects of colonial settlements. We support our assumptions by providing comparative evidence on the evolution of public finances during the colonial period and after independence, and by documenting how determinants of health care provision such as external aid, health staff, and bed capacity have grown during the same period.

3.1 Why does colonial investment matter?

We first hypothesise that the post-independence period is characterised by a shift in the efficiency of infrastructure investment, and infrastructure endowment. Second, during the postcolonial period, it may be inexpensive at the margin to financially maintain an existing network of comparatively more effective hospitals, for which the initial sunk investments were higher and have lasting effect on hospital capacity. While public expenditures and investments were relatively high during the colonial period, the newly created state provided comparatively lower capacity to raise revenue and reduced willingness to invest in the public sector. The establishment of a tax system based on custom tariffs, and tax on profits and revenues, provided important revenues to the colony (Gardner, 2013). The simultaneous collapse of the state and the economy right after independence, and again during repeated periods before and after the fall of Mobutu, significantly reduced the government's capacity to finance health care (Frankema and Buelens, 2013). Comparatively higher levels of public resources were more susceptible to be allocated to public hospitals than after independence. In addition, the emerging nation lost its financial and technical support from Belgium. The majority of skilled workers fled the country following independence to escape the rising political instability, leaving behind Indigenous Congolese with no formal training in business, administration or medicine (Vanthemsche, 2012). Altogether, independence represented a negative external shock on the structural capacity of public investment in all sectors of the economy which should have affected all newly created (post-independence) health facilities.[12] The increase in Development Assistance for Health (DAH) in the DRC since 2008 (Figure A2 in the Online Appendix) is unlikely to invalidate our assumption: the share of government health expenditure represents approximately 10% of the total budget including DAH, a proportion similar to what is observed during the colonial period. However, only 4 post-independence hospitals in the sample were constructed after 2008. In the following, we provide further historical evidence in support of this claim.

3.2 Historical patterns of public finances

There is ample historical evidence that under the colonial regime, the Belgian Congo had higher levels of public financing, skilled workers, quality of institutions, transportation, and communication network than after independence (Vanthemsche, 2012). Yet, spurious causal effects of colonialism on

[12] Similar investment patterns occurred across Africa following the fall of colonial regimes (Barnum, Kutzin, et al., 1993).

modern health facilities could arise if we ignore historical periods and development paths that followed independence (Austin, 2008). Structural changes in institutions and fiscal structure, as well as and policy reforms in the post-independence period may have durably and substantially affected the health sector and health care providers. To address this concern, we first document the long-run evolution of health care financing, as well as public revenue and expenditures in the DRC.[13] We provide more detail on the construction of the long-run series in Online Appendix C.

Figure 2 illustrates the evolution of the share of domestic health expenditures in the total budget between 1920 to 2020. In the early period of the Belgian state, the share of public resources allocated to the health sector was relatively small (6%) but rapidly increased by the late 1920s as the colony introduced its first medical campaigns. The Great Depression and World War II temporarily reduced the willingness of the state to spend on the health sector, which increased again in the late colonial period (1948-1959). The figure depicts a structural break in the share of domestic health expenditures before and after Independence in 1960. The last four decades of the colonial presence before independence are characterised by a share of domestic health expenditures that fluctuates between 8 and 13%. In the immediate aftermath of the independence, the public allocation of health resources almost dropped to zero, with most health workers being unpaid (EEC, 1963). The share of domestic spending significantly declined to 5% during the first decade of Mobutu's regime, became almost insignificant in the 1990s with the economic collapse of the State, and has fluctuated around 5% during the last two decades. Importantly, periods with increased public revenues and national income did not induce major changes in the government's participation in health care expenditure (Figure A15 in Online Appendix).

We further supplement this analysis with the evolution of total government revenue and expenditure to GDP ratio during the last century (Figure A16). After recovering from the collapse of the state in the immediate aftermath of independence in 1960, the country improved its fiscal revenue, mostly through its mineral resources, with about half of the total budget coming from the largest mining state's company, Gecamines (World Bank, 1977). This effect was short-lived: the fall in copper price during the 1970s significantly and durably deteriorated the fiscal capacity of the Congo, as the government was unable to keep up with the rapid pace of domestic inflation (Bension et al., 1980). During this period, the financial difficulties of the Gecamines lead to a dramatic fall in taxation on foreign trade and considerably deteriorated the revenue base of the government, a finding that echoes the empirical evidence in former French colonies (Cogneau et al., 2021). The figure also indicates that after independence, expenditures have mostly exceeded revenue, reflecting both the reduced capacity of the government to raise revenue and the excess of public finances. Nonetheless, the latter was not geared toward the health sector (Figure 2) but may have rather benefited an elite group of the military and administrative sectors (Mock et al., 1990). Importantly, the shift of the post-independence government's behaviour away from public healthcare financing may have considerably impoverished the health sector.

[13] From 1950 onward, we rely on Maddison (2001) to cross-validate the aggregate population and revenue series that we directly collect from national sources.

3.3 Evolution of hospital resources

After independence, a sudden exodus of European health personnel (Figure A9 in Online Appendix) temporarily reduces the availability of health workers in the country. However, the share of medical personnel in the total population recovered in the early 1970s and has continued to grow with a similar trend as the one observed during the colonial period. On the other hand, the number of beds per 1,000 has sharply decreased since independence, reflecting a lack of investment in health infrastructures to address population growth.

4 Data

We construct a new dataset that combines detailed administrative data on hospitals in modern DRC with matched colonial data obtained from the colonial archives of the Belgian Congo. We briefly summarise in this section our sources, and key outcome variables. We discuss the construction of the dataset in more detail in Online Appendix, Section B.1.

4.1 Sources

Colonial status. The treatment of interest in our analysis is the historical origin of contemporaneous hospitals. To establish whether a hospital resulted from a colonial settlement, we rely on two primary data sources. First, we construct a novel dataset of all geocoded colonial health settlements during the colonial period. We collect and combine colonial maps produced by the Belgian Ministry of Colonies that depict the locations of all hospitals and dispensaries that reported health activities to the colonial government between 1929 and 1959, a period corresponding to the development of healthcare provision in the colony. Each map contains information about the type of health infrastructure (hospital or dispensary), the population served (Europeans or Congolese) and the ownership (government, religious or private). Figure A4 provides an example of such maps, with the establishment of medical infrastructures in 1953. We supplement this information with additional maps that report the health activities of a major governmental-supported health organism, *Fondation Reine Elisabeth pour l'Assistance Médicale aux Indigènes*(Foreami), in the western provinces of Kwango and Bas Congo in 1935. Lastly, a detailed map of all existing Christian missions (catholic and Protestant) in 1929 provides additional historical evidence of the colonial presence (Figure A5). The latter does not contain enough information to determine whether a Christian mission provided health services or solely focused on religious activities. However, Christian missionaries considered health activities as an important vector for spreading their faith (Au and Cornet, 2021); their presence could then potentially imply the provision of health services during the colonial time. If a 1929 local religious mission becomes subsequently a healthcare provider during the colonial period, we establish its primary healthcare activities from at least 1929.

Modern hospital data. The list of modern hospitals was obtained from the District Health Information System (DHIS2), a routine web platform managed by the Congolese Ministry of Health that provides monthly financial and epidemiological information on all legal health facilities in the DRC between January 2017 and December 2021. Lordemus (2022) provides an introduction to these data. To improve comparability, we restrict the data sample to hospitals, as reported in the DHIS2 (all health care establishments with at least surgery, paediatrics, general medicine and gynaecology-obstetrics departments).

We then compute the exact location of modern health facilities with colonial origins by matching the colonial health settlements with modern health facilities in the DRC.

4.2 Outcome variables

Our main empirical analysis focuses on the colonisation's influence on modern hospital bed capacity and government transfers. We also consider outcomes related to health services production, to investigate any potential differences in the production function of a hospital for a given set of inputs (Street et al., 2010).[14] Hospital outcomes are based on the pooled average of 48 monthly data extracted between January 2017 and December 2021.[15]

Government transfers. They correspond to public resources allocated by the central government to hospitals (public, private, and faith-based). The transfers are mostly targeting public and faith-based hospitals (each with a share that varies between 30 to 50%), while the share allocated to private hospitals varies between 10 to 20% (Figure A14 in Online Appendix). Government transfers are essentially used for payments of personnel (base salaries and occupational risk allowances), but tend to be relatively low and frequently delayed (MSP, 2019).[16] Online Appendix A.5 provides a detailed review of government transfers and salary payments in the DRC. A recent study from World Bank (2021) finds that salary payments account for 98% of government transfers (excluding non-salary expenditure at the central service and province levels) in the DRC. The number of health workers employed in a hospital should then be a strong predictor of government transfers.

Bed capacity. We proxy structural capacity, a critical determinant of the production function of a hospital, with bed capacity. We collect information on the total number of beds as reported by hospitals in the DHIS2.

Health production. We capture health services production with the total number of admissions (outpatient and inpatient), the number of emergency department visits, the number of severe malaria cases treated, and the number of patients treated for severe diarrhea. Malaria is endemic in the DRC: it is the first cause of mortality among children below five, and one of the highest disease burdens in the

[14] The issue of the most appropriate method for modelling hospital costs is subject to debate depending on whether hospitals should be analysed under the perspective of a firm or a non-profit organisation (see Pauly (1987)).

[15] We cannot exploit the original panel structure of the data since hospital fixed effects would wipe out any long-run colonial effects that we aim to estimate. Results are robust when we consider the median of all variables of interest.

[16] Top-up salaries usually supplement government transfers for health workers and can take various forms such as fees on patients that are not formally reported (Bertone et al., 2016).

country.[17] Diarrheal diseases are another leading cause of mortality and morbidity, and a major public health concern in the country. Finally, the number of patients received in emergency departments should reduce concerns about endogenous selection of patients, especially in settings such as the DRC where the majority of the population has poor physical access to a hospital (Ouma et al., 2018).

4.3 Control variables

Health staff. Our main explanatory variable is Health staff which comprised of three categories of nurses (with low, middle or high qualification level) and physicians (general and specialists). Yet, the tasks assigned to both nurses and physicians can considerably vary across hospitals. Anecdotal evidence suggests that physicians may intervene in fields outside their area of expertise when hospitals are lacking adequate specialists. Likewise, nurses are often required to support function beyond their qualification to compensate for the lack of trained personnel. We address this challenge by pooling the three categories of nurses into one category of health workers, and the general and specialist physicians into one physician category.[18]

Population and ownership. Data on population in the catchment area of a hospital is collected from DHIS2, and corresponds to the estimated population in the health zone of the hospital. We further collect data on the ownership of a hospital, which can be either public, faith-based or private, corresponding respectively to government, religious missions and private firms during the colonial period.

4.4 Final sample

Our final sample comprises 1,393 modern hospitals of which 301 have a colonial origin. Figure 1 shows the locations of colonial and post-colonial hospitals that are used in the final sample. Table A4 in Online Appendix presents the numbers and shares of colonial hospitals in our data sample by ownership right before independence and in modern days. While the share of faith-based hospitals, previously owned by religious missions, remains relatively unchanged, the share of hospitals owned by private firms shrinks from almost 20% in 1959 to 5% in present days, mostly through a reconversion of private hospitals to public ownership. In Online Appendix Table A5, we estimate and characterise the colonial hospitals whose tracks have been lost after independence. Panel A first indicates that about 25% of hospitals recorded in the colonial archives are no longer in the modern list of hospitals, either because they ceased to exist or became incorrectly classified as post-colonial hospitals.[19] Panel B lists the number and share in total hospitals recorded in 1959 whose lost track could be identified (unmatched georeferenced location in the modern list of hospitals) by ownership, and panel C lists the number and

[17] The global health data from IHME provides a detailed ranking of the disease burden in the DRC: http://www.healthdata.org/democratic-republic-congo.

[18] Physicians often split their work between different hospitals and private practices, but we do not have information on their working time in a hospital. For this reason, we keep physicians in a separate category from the rest of the health workers, and show the robustness of our results when excluding physicians.

[19] Hospitals changing names without a clear track record. We discuss this bias in the following Section, with the IV approach.

share of colonial hospitals that could not be tracked, either because the georeferenced location of the colonial hospital was unknown, or because the name and the georeferenced location could not be clearly matched with a modern hospital.[20] The table documents that 15% of colonial hospitals are lost with almost certainty (unmatched names and georeferenced location with modern hospitals), while only 11% of lost hospitals could not be tracked, and for which uncertainty about the colonial status remains.

About 20 percent of hospitals (all built after independence) could not be geocoded and are mostly small structures located in rural areas.[21] This sample selection raises potential concerns: it could lead to underestimation of the colonial effects on health facility performance if the hospitals with unknown locations also have lower performance. However, the sample of geocoded hospitals contains all of the recorded General Referral Hospitals (*Hôpital Général de Référence*, HGR) in the country.[22] In the results section, we discuss the implications of the colonial effects on urban and rural hospitals.

Table 1 presents the descriptive statistics with the mean and standard deviation of the outcome and control variables, for both hospitals with and without a colonial origin. The last two columns present respectively the simple difference in means between the two groups of hospitals, and the values of the t-tests. Postcolonial hospitals are more concentrated in urban areas, with closer distance to the nearest hospital and the provincial capital, have a smaller infrastructure, and almost half of them is owned by a private source. On the other hand, about two-third of colonial hospitals is under public ownership, and almost one third is owned by faith-based organisations. These imbalances might be problematic if hospital characteristics systematically correlate with both colonial status and the outcomes of interest. In particular, the fact that private hospitals are largely underrepresented among colonial hospitals may come as a concern if hospital ownership affects the treatment and the outcomes in unobserved ways. In the following section, we present both permutation tests with placebo treatments, and matching exercises to rule out any significant bias in our main results.

Finally, Table A6 in Online Appendix explores the main drivers of the intensity of colonial health investments. Bed capacity is used to capture the intensive margin of these investments. The first column presents the effects of several geographic characteristics that could have affected the allocation of health resources during the colonial period. The second column adds early and pre-colonial controls that could have been critical to the colonial investment decisions. The results indicate that population density during the final decade of colonial rule is the strongest predictor of health investments, corresponding to the timing of the ten-year public investment plan.

[20] Colonial hospitals in urban areas with higher concentration of hospitals are more likely to be unmatched since the postcolonial names could not systematically be verified, as small discrepancies always exist between the georeferenced locations recorded in the archives and in those obtained from the recent data sources.

[21] However, we can identify the province and health zone to which they belong. Hence, we include all hospitals in the district-level analysis to ensure the robustness of the results.

[22] General referral hospitals (HGRs) are provincial hospitals that provide tertiary care.

5 Long-Run effects of colonial health settlements

We first show that the colonial origin of a health facility is correlated with contemporaneous government transfers, and bed capacity. We then examine the robustness of these initial results, and assess the plausibly causal effect of colonial settlement in three ways. First, we use a large set of historical and geographical covariates that ensure we make local comparisons, and rule out confounding effects of modern hospital locations. If colonial health settlements were located in the most favourable locations for running a hospital, we would not expect to see a relationship conditional on the covariates. Second, we demonstrate the strength of our results with propensity score matching. Third, we use an instrumental variable approach that relies on the geographic distribution of sleeping sickness during the colonial period.

5.1 Relationship between colonial legacy and facility performance

We start by estimating the reduced-form relationship between colonial health investments and contemporary health facility performance using ordinary least square (OLS) regressions. The cross-sectional equation is

$$\mathbf{Y}_{ij} = \alpha_j + \beta Colonial_{ij} + \mathbf{X}_{ij}^{'}\gamma + \epsilon_{ij} \tag{1}$$

where $\mathbf{Y}_{ij}$ is the outcome of interest for hospital i in province j, $Colonial_{ij}$ is a binary variable equal to one if the facility was originally constructed during the colonial period (before 1960), 0 otherwise; α_j denotes the regional (provincial) fixed effects which include all provincial level factors that may affect hospital performance. In the decentralised Congolese economy, each of the 26 provinces of the DRC is ruled by a local government with a small autonomous budget. However, only 8 % of public domestic health spending is coming from provincial governments, while 80% finds its source from the central government.[23] The provincial fixed effect thus accounts for unobserved heterogeneity across provinces which might receive more subsidies from the central government or be prone to more disease outbreaks. The coefficient of interest is β which captures the relationship between colonial settlements and current health facility outcomes.

$\mathbf{X}_{ij}^{'}$ is a vector of additional controls that includes a set of hospital baseline and geographic characteristics. We account for the total of population served by hospital i, as well as the number of nurses and physicians working in the facility. The inclusion of health workers is important since it should be the main driver for government transfer, although it comes at the potential cost that health workers may partly be outcomes of colonial exposure through bed capacity. In Online Appendix, we demonstrate that the results continue to hold when excluding both nurses and physicians (Table A8).[24] We use the natural logarithm transformation on all non-dummy variables to reduce the skewness.[25] We control for latitude and

[23] The remaining share being attributable to other administrative services and mutual funds (MSP, 2019).

[24] We further show that the results are robust when accounting for non-linearities in health workers in Appendix Table A7

[25] All baseline results are similar when using inverse the hyperbolic sine transformation.

longitude to account for the fact that some locations could have different hospital outcomes for reasons unrelated to the observed hospital characteristics (e.g. proximity to informal drug providers). Additional geographic covariates include slope and elevation, distance to the provincial capital (to capture a sense of remoteness of the hospital), distance to the nearest Regional Distribution Centre of pharmaceutical products, distance to the nearest hospital, and distance to armed conflict. These distance measures can be strong determinants of the availability of health care products and health service delivery in the DRC (MSP, 2011).

Malaria is one of the most important health burden in the DRC, and accounts for an estimated 12% of all malaria cases reported in the world in 2020 (Organization et al., 2021). We account for the spatial variations of the risk of malaria transmission by using the median value between 2017 and 2018 of the Plasmodium falciparum parasite rate (PfPR) provided by the Malaria Atlas Project.[26] We exclude from the data sample the largest hospital in the country, Kinshasa General Referral Hospital, whose financial and structural capacities largely outperform the rest of the data sample.[27]

Historical and geographical characteristics, which might have determined the mission locations of the colonial enterprise, might continue to affect modern facility performances in ways that spuriously attribute a causal role to colonial activities (Good, 1991; Jedwab et al., 2022). To reduce the threat of endogeneity, we supplement this set of controls with the distance to the nearest historical transportation mode (railway, road or navigable river), a dummy variable for the exploitation of natural resources during the colonial rule, soil suitability for cassava[28], and population density in 1951.[29] To obtain this information, we digitised detailed maps from the Ministry of Colonies in 1918 and 1952 on the communication channels in Belgian Congo (Figure 3) and the spatial distribution of natural resources in the country. Additional information on transport connections and resource exploitation from the International Bank for Reconstruction and Development IBRD (1957) supplements the mapping before independence in 1960.

5.1.1 Main Results

The baseline results are presented in panel A of Table 2 for six key outcome variables. The first two columns present the patterns for bed capacity and government transfers. Columns (3) to (6) examine four outcomes of hospital production: total number of admissions (outpatient and inpatient), number of severe malaria cases treated, number of patients treated for severe diarrhea, and number of patients received in emergency units. All specifications include all controls and provincial fixed effects. The estimated

[26] The PfPR parasite rate is an index of malaria transmission intensity which estimates the proportion of children aged 2 to 10 who carry the parasite (Hay and Snow, 2006). Annual medians of PfPR were obtained at approximately 5 km resolution from the Malaria Atlas Project (`https://map.ox.ac.uk`).

[27] The results remain qualitatively robust to the inclusion of Kinshasa General Hospital.

[28] Cassava was the leading crop production in Belgian Congo.

[29] Although the estimates are well documented at the subnational level in the colonial reports, we acknowledge the caveat that population density during the colonial time was likely underestimated (Frankema and Jerven, 2014). We establish the robustness of our results to using population density in 1800 from the History Database of the Global Environment (HYDE).

coefficients on the control variables are reported in Online Appendix Table A9. The results show that government transfers and bed capacity are strongly and positively associated with colonial settlement. The magnitudes of the coefficients indicate that colonial origin increases government transfers and bed capacity by respectively 52 and 50 percent.[30] In contrast, the coefficients on health production show that colonial settlement has little or no significant effect, except for the number of malaria-treated patients (in the following subsection, we show that this last result is not robust to alternative empirical strategies). In particular, the number of patients received in emergency care and treatment for diarrhea is similar between colonial and post-independence hospitals when controlling for the number of health workers and geographical factors, suggesting that both groups exhibit similar efficiency in resource utilisation. To better compare the magnitudes across the specifications, we report the standardised beta coefficients which confirm that the strongest effect are found for government transfers and bed capacity, with a one standard deviation (SD) predicting 0.11 and 0.18 SD increase in the respective outcome variables.

5.1.2 Robustness

We investigate the robustness of our initial results in several ways. Since the error terms across the equations for each outcome of interest are likely to be correlated, we also use the Seemingly Unrelated Regressions (SUR) technique that stacks all equations and estimate the model with Generalised Least Squares (GLS). Table 3 indicates that the effect on government transfer and bed capacity remain strong and significant, while the colonial effect becomes insignificant on all other outcomes.

We further show that inference is robust to several alternative approaches to the structure of the error term. Online Appendix Table A11 allays the concern about the small number of clusters, and reports standard errors clustered at the provincial level, using the wild cluster bootstrap procedure for few clusters (Cameron et al., 2008). To further account for spatial distortions causing low standard errors (Kelly, 2019), we apply the Moran test for spatial autocorrelation in residuals. The related p-values in Online Appendix Table A11 suggest that the colonial effect is unlikely driven by spatial noise. Next, in Table A12, standard errors are adjusted by clustering observations within circles from 100 to 1000 km, following the method of Conley (1999) and developed by Colella et al. (2018). The covariance matrix in Conley's method is a weighted average of spatial auto-covariances that are equal within some radius distance of observations and with zero covariance beyond the cutoff. The first row reports the coefficient of the colonial settlement from equation (1) and the following rows report the standard errors when changing the variance-covariance matrix through a change in the distance cutoff of the spatial clusters. Again, the results for government transfer and bed capacity are remarkably robust to the radius of Conley correction.

One concern is that not all hospitals could be localised, which in turn could affect the results if known hospital locations correlate with hospital outcomes. Panel A of Table **??** in Online Appendix shows the

[30] The dependent variable is log-transformed and $Colonial_{ij}$ is a dummy variable. Hence, a one unit change in $Colonial_{ij}$ leads to $(exp(\beta - 1)) \times 100$ percent on the dependent variable.

results hold when only controlling for the baseline covariates without geographic factors in our main data sample, and in panel B when adding hospitals without geo-coordinates. Specifically, the coefficients on colonial settlement for bed capacity and government transfers are of similar magnitude to the baseline results, and give reassurance that the absence of unlocated hospitals in our main sample should not significantly affect the baseline results.

Omitted variables. We assess whether unobservables could drive our results. For government transfers, Table A14 in Online Appendix investigates the sensitivity of regression coefficients to controls for observables, using the method developed by Oster (2019). Starting with only Health workers (nurses) and population coverage in Column (1), we add physicians and province fixed effects in Column (2), and the full set of baseline controls in Column (3). Column (4) presents the most demanding specification, with a matching exercise that we draw from Bazzi et al. (2020): for each province, we match hospitals with the most similar share of health workers in total health workers within the province, and create an indicator for the matched pairs - resulting in 254 fixed effects. With this matching exercise, we can account for any unobserved hospital characteristics related to the distribution of health workers which could drive the colonial effect. Table A15 in Online Appendix presents a similar exercise for bed capacity. Columns (5-8) further replicate Columns (1-4) with Poisson regressions of the number of beds, and show the results are robust to this alternative functional form.

Despite a strong increase in the R^2, the estimates of the proportional degree of selection of unobservables δ at which the colonial effect $\beta = 0$ remain above the minimum recommended threshold of one (Altonji et al., 2005, Oster, 2019) for both government transfers and bed capacity as dependent variables. With bed capacity, the negative δ parameter even indicates that the inclusion of controls increases the magnitude of the coefficient associated with colonial origin. This suggests limited scope for omitted variable bias, since selection on unobservables would have to be significantly greater than selection on observables to invalidate our results (Altonji et al., 2005).

Subsamples. We further assess how much our results depend on the capital city Kinshasa. The city has historically received higher shares of public resources relative to the rest of the country (World Bank, 2021), and its hospitals might directly affect the long-run association with colonial settlements. Table A10 in Online Appendix indicates that our baseline results are not sensitive to excluding hospitals in the capital city and its large agglomeration. Likewise, the outbreak of Ebola virus disease between 2018 and 2020 in the Kivu region and Ituri in the eastern DRC could differently affect hospital outcomes and mislead our results. Finally, our results might be sensitive to regions plagued by continuing conflict and violence, such as the North and South Kivu provinces in the eastern DRC, Ituri (ethnic conflict), or the Kasai region (sparked by tensions between the government and local chiefs). We show that the results hold when we drop all hospitals from the affected provinces. The stability of estimates in this exercise points to a persistent colonial effect that is common across provinces in the country.

Permutation tests. Online Appendix Figure A17 performs permutation tests for government transfers and bed capacity, where we randomly reassign the colonial status of hospitals and re-estimate equation (1), with 1,000 replications. The intuition behind the test is that similar treatment magnitudes should not be estimated in cases where hospitals do not have a colonial origin. The results rule out spuriously correlated effects: for both government transfers and bed capacity outcomes, the graphs show that the distributions of these estimated placebo effects are well outside the effect size of the actual treatment.

Missing values and data quality. A spurious relationship between colonial origin and government transfers could arise if colonial hospitals have a higher reporting rate, and better data quality. Another concern is the relatively high rate of hospitals not reporting any government transfers. This could be problematic if the non-reporting is caused by other reasons than not receiving any transfers, such as low capacity for reporting (e.g. transport access, or insufficient administrative staff), or low incentives to do so (e.g. existing resources from third-party funders). To address this possibility, in Online Appendix Section D.1, we provide an extensive discussion on the current existing tools that assess data quality in the DHIS2, and show that the colonial status of hospitals does not affect these quality outcomes. We further interpolate missing values with different simulation exercises, and show that the colonial effect on government transfers remains sizeable, which reinforces our confidence that underreporting does not drive our results.

While these results paint a consistent picture of the effects of colonial health settlements, there are reasons to be cautious in interpreting them. Historical and geographical characteristics might have determined the mission locations of the colonial enterprise in ways that are not fully accounted (Good, 1991; Jedwab et al., 2022). Since hospitals were relatively capital intensive investments, their constructions must also have been accompanied by clear expansion strategies. Other unknown determinants of hospital's characteristics may also be correlated with colonial origins. We address these concerns with alternative identifying strategies: matching estimation and instrumental variable.

5.2 Matching estimation

While the OLS derives a functional relationship between the outcome and observed facility characteristics, our second approach uses propensity score matching, comparing colonial and post-colonial hospitals, to allow for complex interactions. Online Appendix E provides supportive evidence for the validity of the matching estimation.

Panel B of Table 2 reports the results using the biased-corrected matching estimation proposed by Abadie and Imbens (2011) that adjusts for the differences in covariate values within the matched sample with more than one continuous matching covariate. The Table reports the results using one nearest-neighbour matching algorithm, three nearest-neighbours in the first and second row respectively, using as matching variables the baseline controls in panel A of Table 2. To reduce heterogeneity, we impose exact matching on the type of hospital (referral vs non-referral), by defining a dummy variable equal to one if a hospital is a general referral hospital, HGR.[31] The results point again to statistically and quantitatively significant effects. The third row presents a more demanding specification with exact matching on health worker size quintiles, which compares hospitals with the same quintile of the number of health workers while using baseline controls and geographic coordinates to find the three nearest neighbours. This last matching approach yields the highest estimated effect of colonial origin on government transfers. The last row presents an alternative approach with the entropy balancing algorithm described by Hainmueller (2012) and implemented by Hainmueller and Xu (2013), where the weights of the post-independence hospitals are adjusted to match the mean and the variance of the covariates of colonial hospitals, increasing thereby the comparability of the two groups. This more restrictive approach leads to qualitatively similar results, with magnitudes of the effect size comparable to the baseline OLS estimates. In contrast, the estimated effects for each of the health services outcomes are not always significant throughout the matching estimations, and below significance with entropy weighting.

5.3 Instrumenting the colonial origin

We further gauge causality by addressing the potential endogeneity of the colonial presence through an instrumental variable approach to estimate equation (1). We instrument colonial settlements with the historical geographic distribution of the burden of sleeping sickness. The argument is that i) the spread of the epidemics attracted considerable attention and was a strong driver for colonial medical expansion, ii) the disease is spread by a particular parasite carried by the tsetse fly. Although sleeping sickness was endemic in many parts of the country, local populations managed to contain the risk of epidemic outbreaks long before the colonial era (Bruce, 1908), by avoiding certain areas. Colonial expansion shattered this ecological equilibrium, but did not directly cause the outbreak of the disease. It rather affected the existing disease patterns among men and animals, which helped set the stage for the sleeping outbreaks (Ford, 1971). The environmental changes induced by the colonial presence affected the delicate ecological equilibrium between men, tsetse flies and wildlife, and contributed to the episodic nature and unpredictable geographic spread of the epidemics (see Section A.1 in Online Appendix for an extended discussion). The multifactorial background of the disease outbreak makes its geographic appearance quasi-random (Lyons, 2002).

To operationalise this idea, we exploit the reporting from public health archival data of the geographic distribution of sleeping sickness during the colonial period, where the infection rate is at least equal to 1%.[32] Accounting for the distribution of the disease throughout the entire colonial period is important for two reasons. First, in the early years, cases may largely be under-reported in the western part of

[31] An even more suitable approach is the exact matching on hospital type *and* ownership, which leads to even higher coefficient estimates for bed capacity and government transfers. However, this approach is very demanding and not enough exact matches could be found when estimating the effect on Emergency.

[32] This arbitrary threshold aims to consider only geographic areas where the burden of sleeping sickness became significant. The archival maps also report the areas where the infection rate is less than 1%, but without further information about the number of identified cases, we cannot claim that they significantly impacted the location of colonial settlements.

the Belgian Congo where access was more difficult for medical campaigns. Second, the public health measures may have significantly affected the dynamics of the distribution of the disease (Lyons, 2002). By combining all maps on the distribution of the disease during the colonial period, we can identify all geographic areas that had higher differential exposure to sleeping sickness, and in turn predict areas for the presence of medical campaigns (Lowes and Montero, 2021b), and the establishment of new medical infrastructures.[33] Online Appendix Figure A19 depicts the kernel density of colonial health settlements and the health zones (district level) where the presence of sleeping sickness was reported between 1928 and 1953. The Figure illustrates that the prevalence of sleeping sickness is predictive of the colonial presence: it documents a strong spatial correlation between colonial settlements and the prevalence of the disease during the colonial period.

We estimate the following first-stage equation:

$$Colonial_{ij} = \delta Sleeping_{ij} + \theta X_{ij}^{'} + \nu_{ij} \tag{2}$$

where $Sleeping_{ij}$ is a dummy variable equal to 1 if hospital i is located in an area where the infection rate was reported greater than 1% at least once during the last three decades of the colonial period - which coincides with the expansion of public services. The fitted values are then used as explanatory variables for the indicator of colonial origin in equation (1).

Table 4 presents the first stage estimates in panel A for all outcomes of interest, and Panel B reports the 2SLS specifications. The table shows that the presence of sleeping sickness strongly predicts the geographical distribution of colonial settlements: the presence of medical missions increases by nearly 50 percentage points within sleeping sickness areas. The high Kleibergen-Paap statistic (above 187) confirms the previous visual evidence that the instrument is a strong predictor of colonial health settlements.

In terms of magnitude, the IV results indicate that government transfers increase by 52 percentage points in hospitals with a colonial origin, while the baseline OLS results report a 39 percentage points increase. Likewise, the IV coefficient on bed capacity is about 10 percentage points higher than the corresponding OLS estimate. Two elements could explain the downward bias of OLS. First, OLS estimates may suffer from measurement errors. The construction origin of some hospitals may be incorrectly specified, as many hospital names changed after the independence, and it was not always possible to track the new names. While public health reports of the Belgian Congo mention the existence of 408 health facilities in 1959, we could only identify 301 facilities with colonial origins, of which 270 are general referral hospitals. Since the number of health infrastructures that disappeared after independence is

[33]We consider sleeping sickness distribution to be the preferred measure for colonial presence over the geographic distribution of tsetse presence, that provides little variations across the country: Figure A20 in the Appendix shows that only a small region in the Kivus, in the Western part of the country, and few locations in Tanganyika (South West) were reported free of tsetse flies in 1950. Lowes and Montero (2021b) use crop suitability interacted with distance to capital to predict medical campaigns, but in the Belgian Congo, lands where traditional crops were grown have less predictive power for the disease burden. Resource rich areas in gold, rubber or copper involved labour migration and increased the risk of disease transmission (Lyons, 2002). Yet these resources rich areas may continue to affect modern hospital outcomes such as financial transfers. We control for these areas in our regressions.

unknown (converted to other purposes or abandoned), some colonial hospitals that could not be tracked after independence may have wrongly been attributed with a postcolonial status, and thereby explain the attenuation bias of the OLS. Second, the 2SLS coefficients capture the local average treatment effects (LATEs) for "compliers" - colonial hospitals that are within sleeping sickness areas. The effect of colonialism on this subset might differ if sleeping sickness areas have different geographic characteristics. In online Appendix Table A20, we show that hospitals within sleeping sickness areas are closer to major cities, transportation modes, and mineral resources. We expect the effects on government transfers and bed capacity to be higher in those areas than in hospitals located in more rural, isolated places.

5.3.1 Identifying assumptions and robustness

Causal mechanism. Does the instrument satisfy the exclusion restriction? Although the sleeping sickness epidemic had devastating effects on the population of Eastern Africa in the early 20th century (Scott, 1942; Lyons, 2002), its modern burden became negligible compared to other endemic diseases in the region, such as malaria or HIV (Fèvre et al., 2008). Sleeping sickness is now classified as a neglected tropical disease: WHO (2017) indicates that approximately 1,000 new cases were detected in the DRC in 2017, while 34,000 HIV-positive persons were reported to be on treatment and 25 million were estimated to be malaria-infected during the same year.

Furthermore, the parasite causing sleeping sickness is transmitted by infected tsetse fly bites. One could be concerned that tsetse flies and Anopheles mosquitoes, which are responsible for the infection of malaria, grow and survive in similar environmental conditions, leading to overlapping endemic areas between malaria and sleeping sickness. In that case, factors pertaining to the presence of tsetse flies could confound the risk of malaria transmission and affect modern hospital outcomes. First, the colonial authorities reported that the whole country was exposed to tsetse flies, with the exception of regions in the eastern part of the country with higher altitudes and lower temperatures (Appendix Figure A20). Second, the ecological habitats of the two insects differ substantially. While the principal factors that influence tsetse populations are the density of vegetation cover and climate, with temperatures ranging between 20 to 30 degrees Celsius (Fèvre et al., 2008), mosquitoes can survive with a wider range of temperatures but need stagnant water for their breeding sites (Mbanzulu et al., 2020). This is further supported by the significant geographic disparities between the reported infection rate of sleeping sickness and malaria (Online Appendix Figure A21a).

Another threat is that despite our controls of hospital characteristics and province fixed effects, other underlying regional variations could have systematically affected the historical distribution of the disease. For instance, pre-colonial ethnic institutions could have had long-lasting effects on development and public goods provision in Africa (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2013) and could also have affected the distribution of the disease. To check against this possibility, we investigate in Figure 5 the relationship between sleeping sickness and a battery of pre-1920 economic, social and epidemiological determinants of colonial activities. The Figure reports the estimates of colonial settlements on sleeping sickness in 1910 (dummy variable), population density in 1800, population density in 1921, early access to transport using distance (logarithm) to rivers and colonial railway in 1920, ancestral characteristics of ethnic groups using the Ethnographic Atlas (EA), coded by Murdock (1967) and updated by Nunn and Wantchekon (2011), and a dummy variable for early colonial economic activity equal to 1 if a hospital falls into an area that belongs to a concession granted to one of the private companies under the Congo Free State. The results of the falsification tests rule out any spurious relationship between sleeping sickness (1928-1953) and hospitals' colonial origin: they show no statistically significant correlation with colonial settlement across all specifications, and suggest that pre and early colonial characteristics alone do not explain the distribution of colonial health settlements. Rather, it is only with the distribution of sleeping sickness after 1920 which coincides with the expansion of the public economy and the health system in the colony that we observe a channel with the presence of colonial hospitals.

Balance. Likewise, a threat to the identification exists if sleeping sickness areas during the colonial time present different characteristics that continue to affect modern hospital outcomes. We address this concern in Appendix Table A21 by using entropy weights from the balancing algorithm Hainmueller (2012) that imposes hospitals outside the sleeping sickness areas to have the same mean and variance as the hospitals within the sleeping sickness areas for all geographic variables. The results are almost identical to those in Table 4.

Never-takers. Finally, we assess the predictive power of the sleeping sickness instrument on hospital outcomes for the facilities located in areas with sleeping disease during the colonial time, but which were built after independence ("the never-takers"). If the effects of the sleeping sickness instrument are working through the colonial origin of hospitals, then the instrument should not predict higher government transfers and bed capacity for postcolonial hospitals. Figure 6 in Online Appendix plots the reduced-form estimates of sleeping sickness on our baseline hospital outcomes, for colonial and postcolonial hospitals. Consistent with our previous results, the instrument has a positive and significant effect on government transfers and bed capacity only for hospitals with a colonial origin. The effects of sleeping sickness during the colonial period on hospital outcomes are small and statistically insignificant among hospitals built after independence. The absence of predictive power of the instrument with the never-takers strongly suggests that sleeping sickness area has no direct effect on government transfers and bed capacity. These falsification tests rather reinforce our confidence that the instrument affects hospital outcomes only via colonial origin.

Additional robustness checks. To further bolster our confidence in the validity of the instrument, we test potential local violations of the exclusion restriction assumption in certain areas of the covariate space in a data-driven way. We follow the test procedure developed by Farbmacher et al. (2022), which consists of searching for subgroups in the covariate space that maximise effect heterogeneity, and testing for local violations of the exclusion restriction assumption with causal forests. The intuition of the test is that partitioning the data sample in a data-driven way is more likely to uncover heterogeneity, and detect potential violations of the exclusion restriction assumption that could otherwise be reduced or offset in the full sample, and which would undermine the validity of the instrument. Further details about the test and its results are provided in Online Appendix Section F.1. The results rule out local violations and provide further confidence that the historical distribution of sleeping sickness should not be correlated with modern hospital characteristics.

Despite the reassurance of this last test, we also explore the robustness of our results when allowing violations of the exclusion restriction of the "plausibly exogenous" instrument. In Online Appendix F.2, we follow the procedure suggested by Conley et al. (2012) and demonstrate that our results hold even when relaxing the strong exogeneity assumption.

6 Channels

Our results suggest a higher degree of persistence of colonial settlement on government transfers and bed capacity. For the latter, the comparatively higher level of investments in health and public work during the colonial rule compared to any other periods after independence strongly supports the view made in Section 3 that colonial hospitals were generally better equipped and of a higher structural capacity: high initial sunk investment could therefore be a strong channel for the long-lasting impact on the physical capital of hospitals.

The finding on government transfers is more puzzling: once controlling for health workers, why would modern hospitals with colonial origins receive a higher governmental grant than their counterparts? We hypothesise and provide suggestive evidence that hospitals with a colonial origin may have developed into a network of hospitals that can better attract funds through lobbying activities with the government and donors' influence. We also consider additional channels that could further explain the results, and show that none of them are predicted by colonial health settlements.

6.1 When and where colonial origin matters?

Early settlements and European hospitals. We first attempt to elucidate this question by decomposing the colonial effects by hospital ownership and the timing of colonial first settlement. The earliest hospitals were primarily built for the Belgian and European populations. The two-tiered system of healthcare provision between Europeans and Congolese (Figure A6) could lead to varying and potentially opposing effects on modern hospitals. In particular, the low public health spending in the postcolonial period could be interpreted as a continuity of relatively low spending for native Africans during the colonial period. In Table 5, we examine the extent to which the relative date of the first colonial settlement and the type of colonial facility affect the association with hospital outcomes. Variations in public health spending and general public investment (as in the ten-year plan) during the colonial rule could differentially affect the historical persistence on contemporaneous hospitals. In particular, hospitals built after 1949 (during the ten-year plan) may have a different structure capacity than health facilities built at the early stage of the colonial rule. The results indicate that the period of the colonial hospital foundation does not affect the outcomes of interest. We also anticipate differences across the type of colonial facility (European or Congolese) if the initial differences in the quality of health care provision were caused by structural capacity.[34] Table 6 show that the racially distributed colonial health infrastructure does not play a significant role in the allocation of modern public health resources and bed capacity.

Religious missions. The colonial effects are not driven by health settlements built from religious providers during the colonial period. However, early Christian missions before 1930 differ from Christian health care providers in the later colonial period. Early religious missions were not financially supported by the state for the provision of health care, and as a result did not always construct a hospital or health centre. Yet, they may have had an influential role among local populations through their early presence and religious activities, and in persuading colonial authorities to provide public health services in the later colonial period. We rule out this possibility in Table 5 by showing no statistically significant effect of the dummy variable for early religious presence before 1929.

Past and modern funding sources. Table 7 investigates whether colonial funding source and modern hospital ownership differently determine the effect on government transfer and bed capacity.[35] Columns 1-4 investigate the effect on government transfer, and columns 5-8 report the estimates with bed capacity as the outcome. The source of colonial funding may capture varying levels of investment intensities and potentially different development paths since the state, Christian missions and private firms had their own health budget and objectives for the provision of health services. For instance, private firms operating in mining concessions could have been more inclined to spend comparatively higher on health care services to preserve the health status of their local labour force. Likewise, mission hospitals biased their healthcare services to Africans (Janssens, 1972). For contemporaneous ownership, we conjecture that public hospitals should receive more subsidies from the central government, while private hospitals might operate at lower costs (Street et al., 2010).

The first panel of the Table indicates no significant effect of the colonial funding source on contemporaneous government transfers and bed capacity. This suggests that colonial investments for the construction of health infrastructure may not have systematically differed across the three funding sources. This result is unexpected since historical evidence suggests that the colonial regime primarily aimed to expand the construction of health facilities across the colony (Duren, 1953) while Christian missions and private firms were devoted to local roles around their respective areas of activities (Lyons, 2002). Panel B complements this picture with modern hospital ownership, which may have changed after in-

[34] Colonial hospitals were not always exclusively for Europeans or Congolese, but could have dedicated units for each of the two populations.

[35] The teaching status of a hospital would have been another important characteristic to explore, but only scare information was available.

dependence as the three funders had different incentives to maintain ownership of a hospital in the postcolonial period. As expected, the results suggest that private hospitals are less likely to receive government transfers in general, but modern hospital ownership of colonial hospitals has no statistically significant effect on government transfers. On the other hand, private hospitals with colonial origins have higher bed capacity, and faith-based hospitals built during the colonial period are significantly smaller. No statistically significant effect is found on the structural capacity of public hospitals with a colonial origin. These findings suggest an interesting pattern of historical ownership and structural capacity in the development path of modern health facilities: whilst health infrastructure had a similar size across ownership during the colonial period, private investors may have more systematically preferred to select larger hospitals, and faith-based owners shifted towards smaller structures after independence. Investment capacity to maintain large hospitals, and economies of scale may explain these differing investment choices. Unfortunately, the absence of refined hospital-level data during the postcolonial period limits our analysis.

6.2 Does foreign aid support colonial hospitals?

Donors may play a mediating role in the distribution of government transfers if the central government aligns resources with (or diverts from) externally funded hospitals. One challenge lies in the absence of data on the specific amount of external aid each hospital receives, as donors do not provide this information at a disaggregated level. To circumvent the issue and explore donors' support to hospitals, we first leverage the presence of drugs related to tuberculosis (TB) and HIV in hospital pharmacies. Along with malaria, the two diseases attract the highest share of Development Assistance for Health in the DRC (MSP, 2019). Due to extremely low domestic public health expenditure, donors finance almost entirely these three disease programmes and are involved in the provision, storage, and distribution of the related health products (MSP, 2011). Since the costs of TB/HIV related drugs are very high compared to antimalarial medications, their availability is more likely to reflect donors' financial and technical support. We supplement it with information collected from the major health-related donors in the DRC on hospitals that have been supported at least once during the period of analysis (2017-2021).[36]. Finally, we complement it with data from the DHIS2 on hospitals supported by USAID.

Table 8 reports the estimates of colonial settlement across multiple regressions with differing aid-related dependent variables, using a linear probability model. Pair columns present the results for all hospitals, and impair columns consider only public hospitals. In Column (1), we construct a binary health aid outcome variable equal to one if a hospital received donor support at least once during the sample period. In Column (2), we restrict the health aid outcome to US aid Since the US government is the largest donor, its influence on the central government decisions may be particularly strong. In Column (3), we construct local aid data that covers all general aid support from Western donors. The

[36] This information was collected from the DRC websites of MSF, the International Committee of the Red Cross, USAID, Global Fund, WHO, World Bank, and the UK Department for International Development.

local aid outcome corresponds to the logarithm distance from a hospital to its nearest geocoded aid project between 1998 and 2014 as reported by the DRC AIMS Geocoded Research Release (Online Appendix B.3 for detail).[37] Finally, Column (4) considers the log-distance to projects funded by Chinese aid only, as this source of aid has been shown to be discretionary and prone to aid diversion (Isaksson and Kotsadam, 2018; Dreher et al., 2019). The results are similar with a logit model. Colonial hospitals are 7 percentage points more likely to receive health aid support, relative to a mean of 78%. The effect is significant at the one percent level. There is not a statistically significant impact on US health aid. When considering external aid in general without targeting health, the proximity of colonial settlements to local aid projects increases by 30 percentage points $((exp(-0.195-1)) \times 100)$ relative to a sample mean of 2.2 km, as indicated by the negative coefficient. On the other hand, Chinese aid- funded projects are closer to postcolonial hospitals, by 41 percentage points, relative to a sample mean of 3.5 km. In other words, colonial hospitals are more likely to benefit from Western aid both through direct support and by being in proximity to other funded projects with potential positive spillover effects. This result corroborates with Alpino and Hammersmark (2021) which demonstrates a positive correlation between Christian missions and modern World Bank aid locations in Africa. This finding suggests a potential mediating role of aid if the central government aligns its transfers with hospitals supported by Western donors.

How does donor support affect government transfers? Since independence, the state of crisis in the underfunded health sector led to a growing dependence on external aid which increased the influence of donors in most African countries. While on average 70% of modern hospitals is financially supported by external aid in the DRC, Western donors may primarily target health aid to a subset of hospitals that they have historically worked with. Even after the country gained its independence, Belgium, like most other colonial powers, continued to provide financial support to the Congo (former Zaire) along with Western donors. To do so, donors increasingly relied on non-governmental organisations (NGOs) that were promoting their policy and national strategies for financing health projects (Hearn, 1998). In this new postcolonial setting, international aid might have been more likely to target former known and well-established colonial health institutions to achieve local objectives. Focusing on Ghana, Walker (2022) notes: "Missions were laying the groundwork in the 1930s for what would become a huge part of Ghanaian health infrastructure and a network of health practitioners, clinics, and dispensaries that was necessary for international health campaigns to be possible from the 1950s onwards. In conceptual terms and in logistical ones, this period was critical for setting in motion international health policies in the twentieth century. " Other former African colonies are arguably characterised by a similar expansion of health systems. As the DRC has regularly been prone to armed conflict and cyclical outbreak epidemics, the existing colonial infrastructures might further have offered a comparative advantage for donors and local NGOs to provide rapid response to epidemics and achieve short-term measurable objectives on

[37] No local aid information could be obtained for the sample period.

population health (Lorgen, 1998).[38] Donors were further instrumental in the integration of hospitals run by NGOs into the national health system, with the requirement that governments contribute to the running costs of hospitals, and especially their salary payment (Hearn, 1998). Moreover, the success story of local health projects financially and technically supported by donors constituted clear incentives for recipient governments to integrate them into the state apparatus (Gary, 1996).

The proximity of Chinese aid to postcolonial hospitals does not support the view that colonial hospitals are more likely to attract external resources when aid is potentially fungible.

6.3 Favouring better performing hospitals?

Cost-intensive medical care. The disproportionate allocation of public resources towards colonial hospitals could be optimal from the central government's objective if the latter provides higher coverage and quality of health care. The government transfers could either incentivise or reward health workers in comparatively better-performing facilities. Although we cannot directly use data on the quality of health care supply, we test this hypothesis in three ways.

First, we rule out a connection between colonial origin and hospital medical equipment. We begin with constructing a measure of equipment by extracting the first principal component of four measures of equipment utilisation: Glucometer, Microscope, Spectrophotometer, Ketamine for medically-delegated analgesia.[39] Table A23 in Online Appendix shows that colonial origin has a statistically insignificant effect on both the probability of having medical equipment and its monthly utilisation.

Second, we assess additional hospital outcomes that could relate to the provision of the quality of care. Table A24 in Online Appendix shows that colonial origin has no statistical effect on investment, and the stock value of medicine in hospital wards, once we account for the baseline controls and add the number of total outpatient visits. These two results suggest that colonial hospitals are unlikely to have more medicines available, or more modern healthcare equipment. Columns (3), (5) and (7) show the estimated effects of colonial origin on expenditure, revenue and length of hospital stay are positive and statistically significant. We should carefully avoid a causal interpretation since the relationship between each outcome and colonial status could work in both directions. Yet these results may indicate a substitution effect induced by government transfers: hospitals may use the free-up resources otherwise used for salary pay to purchase additional types of furniture and generate higher revenue. Since our baseline results show that colonial hospitals also have larger infrastructures, we control for the number of beds in Columns (4), (6), and (8). The quantitatively small or null effects observed on colonial settlement suggest that colonial hospitals generate higher revenue and provide longer lengths of stay for inpatients primarily

[38] Since its creation in 1924, the DR Congo Red Cross has benefited from continuous support from the International Federation of Red Cross and Red Crescent Societies (IFRC), and funding from USAID.

[39] All are recognised to play a key role in medical decision-making: glucometers are used for estimation of blood glucose levels (e.g. patients with diabetes); Ketamine is used for the management of acute pain; Spectrophotometer is a device used in clinical laboratories that provides quantitative analysis of substances through measuring the absorbance of light (e.g. blood analysis); Microscopes are standard tools that provide accurate observations, and often used to assist complex surgical procedures.

through their larger structural capacity. In other words, there is no evidence that government transfers is associated with higher revenue through better quality of care once controlling for bed capacity.

Third, we explore whether colonialism differently affects secondary and tertiary healthcare delivery (community vs. district/general referral hospitals). The central government may over-fund general referral hospitals that are financially more demanding but provide a higher range of clinical services (e.g. surgery, paediatrics, obstetrics). Furthermore, general referral hospitals occupy a higher administrative position in the national health care organization, they may more easily attract public funds through better signalling or higher visibility. The results presented in Online Appendix Table A25 show that the main results continue to hold with this subset of hospitals. The persistence of the colonial effect at the highest level of health care organization suggests that the effect on transfers is unlikely driven by the government's preference for cost-intensive medical care.

Bed capacity. Our baseline results show a strong positive colonial effect on bed capacity, a proxy for the physical infrastructure of a hospital. Naturally, larger hospitals are more adequate to admit more patients conditional upon a suitable number of health workers. Besides the number of health workers that we control, physical infrastructure may strongly determine how funding is allocated among providers. For instance, the government may systematically overfund the largest hospitals to incentivise the recruitment of additional health workers and reach full capacity for health service delivery. Table A26 in Online Appendix tests against this hypothesis where government transfers is the dependent variable. Column (1) presents the OLS results on health workers and excludes colonial settlement. Column (2) shows the results with only bed capacity and the baseline controls. In Column (3), adding health workers and bed capacity reduces all point estimates, as we should expect with meaningful controls. Lastly, we explore whether health workers and bed capacity jointly explain the full effect of colonial origin. Column (4) shows that the point estimate on colonial settlement remains of similar magnitude and statistically significant. Notice that the relationship between government transfers and bed capacity is not causal, and could work in both directions: the central government may prefer to overfund larger hospitals, but larger hospitals may also be comparatively better in attracting and mobilising public health resources through lobbying efforts, even among hospitals with a colonial origin. However, Table 7 documents that private hospitals with a colonial origin, which tend to have a larger infrastructure, also receive significantly fewer government transfers. This evidence rules out hospital size as the sole mediating factor for the colonial effects on government transfers.

6.4 Additional channels

In Online Appendix Section G we examine additional channels that could drive our results. We first show that colonial health settlements predict neither economic development nor population. Second, our results are not driven by a higher modern risk of malaria transmission. Third, we consider the confounding role of ethnic power, whereby colonial settlements may have been predominant among ethnicities that continue to remain more affluent in modern days, and with higher discretionary power over the allocation of central resources. Fourth, we show that our results are not sensitive to the historical presence of concessions during the Congo Free State period. Fifth, we rule out the possibility that our results are explained by capture from local elites.

7 Discussion and conclusion

In this article, we conducted a novel investigation about the heritage of colonial health activities on modern hospital outcomes. We documented that colonial health settlements in the Belgian Congo established a group of health infrastructures with comparatively higher structural capacity than hospitals built in the postcolonial period. We further demonstrated that hospitals with colonial origins receive higher funding from the central government than their counterparts created after independence. The long-run impacts of colonial health settlements and their magnitude are remarkable in a country like the DRC which suffered from decades of political and economic instability, civil wars, and the complete collapse of the health system.

A plausible channel that can account for this persistence is the difference in initial infrastructure investments between colonial and post-colonial hospitals, in a context of low domestic health expenditures after independence. Moreover, colonial hospitals may have historically established closer connections with the central government. The limited budget of the government and the rampant corruption in the country might have participated in building a network of favoured facilities lobbying for the allocation of public transfers. The historical connection of colonial hospitals with the central government might play a substantial role in attracting more attention from political leaders. At the same time, post-independence facilities, which tend to have lower structural capacity, might be less able to leverage government funding. Colonial investments would, therefore, provide a comparative advantage to colonial hospitals in competing with other health facilities to lay claim to limited public resources. This argument echoes Banerjee et al. (2007) who demonstrate that political considerations can be closely tied to the provision of public goods in resource-constrained settings. The findings in this paper highlight the importance of examining the colonial roots of African health systems, a thorough identification of health facilities built during the colonial era, and their connection with the central government and international donors in the post-colonial period, to better understand contemporaneous inequalities in healthcare financing.

We expect persistent influence of a hospital network to be important in the DRC and other sub-Saharan African countries for various reasons. Public health resources have long been extremely low despite pledges from African governments to increase the share of healthcare budgetary allocations.[40] Hospitals lobbying the government for increased funding could have quickly emerged after independence

[40] In the 2001 Abuja declaration, African governments pledged to allocate at least 15% of their annual national budgets to the health sector.

as a direct way to compete for limited public funds (Hanif and Musvoto, 2023). A nascent literature on the role of governance and politics documents the importance of representative organisations and interest groups in the healthcare sector in competing for their market share and political power, and ultimately reshaping healthcare delivery and financing in LMICs (Sriram et al., 2024). Our results suggest that the colonial heritage can be a strong determinant for gaining market power in the health sector.

An important remaining question is whether these results generalize to other former European colonies. The Congo was the only, but enormous and resource-rich colony ruled by Belgium. Its colonial administration and economic policies were mostly oriented towards the development of resources under the control of European settlers. Other former African colonies experienced different colonial models (e.g. direct control under the French colonial system or indirect rule of British possessions) which differentially impacted the political and economic structure of the respective country during their postcolonial periods (Ali et al., 2019). Nonetheless, the establishment and financing of the health system under European rule, the introduction of Western medicine and disease control, and the similar time frame of the colonial period are common key aspects that have shaped public health in colonial Africa and could continue to resonate in modern health institutions.

Expanding the scope of the current literature to consider how different colonial systems have influenced the development path of health financing is a promising avenue for future research with relevant policy implications. In particular, the observed pattern of persistence of colonial effects on health system development could inform about the potential reallocation of health resources (and in particular external aid) to reduce inequalities in health care delivery and access to treatment.

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Table 1: Summary statistics and difference-in-means

	PostColonial			Colonial				
	Obs. (1)	Mean (2)	s.d. (3)	Obs. (4)	Mean (5)	s.d. (6)	Difference (7)	*t*-stat (8)
Hospital outcomes								
Bed Capacity	904	3.69	0.02	296	4.41	0.03	0.73	-17.69
Government transfers	533	13.73	0.07	263	15.03	0.07	1.30	-13.30
Total admissions	1,042	5.44	0.03	297	5.86	0.04	0.42	-8.25
Malaria cases	1,039	2.93	0.04	301	3.93	0.04	1.01	-17.45
Diarrhea cases	1,040	1.15	0.03	300	1.58	0.04	0.43	-8.35
Emergency cases	812	3.14	0.04	289	3.81	0.06	0.68	-8.77
Baseline variables								
Nurses	1,060	2.27	0.03	301	3.10	0.05	0.83	-14.56
Physicians	1,035	0.94	0.03	301	1.53	0.06	0.59	-9.52
Population	1,088	12.43	0.01	301	12.17	0.03	-0.26	8.36
Hospital ownership								
Public	1,092	0.28	0.01	301	0.66	0.03	0.39	-12.68
Faith-based	1,092	0.36	0.01	301	0.32	0.03	-0.04	1.40
Private	1,092	0.45	0.01	301	0.06	0.01	-0.39	19.38
Geographic controls								
Distance Provincial capital	795	4.53	0.06	300	5.24	0.07	0.71	-7.85
Distance Distributional Centre	795	3.90	0.04	300	4.62	0.06	0.72	-9.54
Distance to transport	795	2.63	0.05	300	2.86	0.08	0.23	-2.44
Distance conflict	795	1.99	0.04	300	2.85	0.09	0.86	-8.67
Distance nearest hospital	797	7.78	0.07	300	9.41	0.10	1.63	-12.93
Distance to Electricity network	795	2.21	0.05	300	2.83	0.10	0.62	-5.54
Distance to coast	795	6.92	0.01	300	6.80	0.03	-0.13	4.01
Population density 1951	793	2.71	0.04	299	2.27	0.06	-0.43	6.72
Natural resources (before 1960)	798	0.54	0.02	300	0.38	0.03	-0.16	4.75
Malaria risk rate	796	0.20	0.01	300	0.26	0.01	0.06	-6.03
Soil suitability (cassava)	797	5,821.50	116.44	300	6,625.12	173.70	803.63	-3.84
Elevation	796	789.72	18.71	300	685.38	23.00	-104.34	3.52
Slope	796	1.18	0.02	300	1.15	0.04	-0.04	0.83
Longitude	798	22.77	0.21	300	22.88	0.28	0.11	-0.32
Latitude	798	-4.09	0.13	300	-2.88	0.24	1.22	-4.52

Notes: The unit of observation is hospital. All variables are taken in logarithm, except elevation, slope, longitude and latitude. The first six columns show the number of observations, sample mean and standard deviation for post-independence and colonial hospitals respectively. The last two columns indicate the difference in means between post-independence and colonial hospitals, the *t*-stat of the test of whether the mean coefficients in the two samples are equal.

Table 2: Colonial settlement and hospital outcomes: main results

Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Panel A. OLS						
Colonial settlement	0.276***	0.337***	-0.087**	0.156***	0.050	0.043
	(0.046)	(0.080)	(0.042)	(0.049)	(0.063)	(0.096)
Standardised β coefficient	0.171	0.108	-0.045	0.063	0.028	0.017
R^2	0.59	0.56	0.49	0.46	0.32	0.39
Observations	981	755	1040	1050	1051	915
Mean dep. var	3.95	14.25	5.64	3.32	1.32	3.44
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Physicians	✓	✓	✓	✓	✓	✓
Nurses	✓	✓	✓	✓	✓	✓
Modern hospital ownership	✓	✓	✓	✓	✓	✓
Local population	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓
Panel B. Matching estimation						
Nearest-neighbor(1)						
Colonial settlement	0.329***	0.328***	0.214***	0.212***	0.078	0.011
	(0.052)	(0.095)	(0.061)	(0.080)	(0.081)	(0.108)
Nearest-neighbor(3)						
Colonial settlement	0.325***	0.403***	0.124**	0.150**	0.038	0.010
	(0.047)	(0.091)	(0.056)	(0.067)	(0.069)	(0.102)
Exact matching: HW quintiles						
Colonial settlement	0.290***	0.437***	-0.008	0.185***	0.060	0.032
	(0.047)	(0.091)	(0.051)	(0.071)	(0.076)	(0.100)
Entropy reweighting						
Colonial settlement	0.309***	0.394***	-0.087	0.163	-0.036	-0.056
	(0.087)	(0.143)	(0.092)	(0.107)	(0.095)	(0.152)
Matching variables as in Panel A	✓	✓	✓	✓	✓	✓
Observations	981	755	1040	1050	1051	915

Notes: Panel A presents the OLS estimates of equation (1). The unit of observation is a hospital. Nondummy variables are all in natural logarithms. Geographic controls include distance to provincial capital, distance to pharmaceutical distribution centres, distance to nearest transport, population density in 1951, malaria risk rate, elevation, longitude and latitude, and distance to conflict events, distance to electricity infrastructure in the DRC, distance to coast, health zone, slope, and a dummy variable equal to one for the exploitation of natural resources during the colonial period. Robust standard errors in parentheses are clustered at the provincial level. Panel B presents the estimates from different matching estimations, using the controls listed in panel A as matching variables, except for province fixed effects. The first three matching methods present average treatment effects on the treated, based on propensity score matching, using exact matching on hospital type (dummy variable equal to one if a hospital is a general referral hospital) with respectively one nearest-neighbour, three nearest-neighbours, and exact matching on health workers (HW) size quintiles with three nearest-neighbours, in addition to using the matching variables in panel A. The last mating approach presents estimates using the entropy balancing algorithm (Hainmueller, 2012) which reweights the post-colonial hospitals to match the mean and the variance of the covariates of colonial hospitals. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 3: Colonial settlement and hospital outcomes: SUR model

	Financing		Health Production				
Dep. Variable	Government Funding (1)	Investment (2)	Malaria services (3)	Emergency care (4)	Treatment diarrhea (5)	Birth (6)	Bed capacity (7)
Colonial settlement	0.261	0.250	0.196	0.062	0.138	-0.038	0.066
s.e.	0.049	0.091	0.135	0.059	0.076	0.072	0.101
p-value	0.000	0.006	0.148	0.292	0.068	0.604	0.515
Standardised β coefficient	0.244	0.120	0.068	0.049	0.088	-0.025	0.032

Notes: Generalised Least Squares (GLS) estimation of equation equation (1) using the Seemingly Unrelated Regressions (SUR) technique (Zellner and Huang, 1962). All baseline controls and provincial fixed effects are included. Robust standard errors are in parentheses.

Table 4: Colonial settlement and hospital outcomes: IV

Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Panel A. 1st stage						
Sleeping sickness	0.423***	0.437***	0.423***	0.425***	0.420***	0.452***
	(0.031)	(0.035)	(0.030)	(0.030)	(0.030)	(0.032)
Kleibergen-Paap F-statistic	188.4	157.0	199.8	206.8	197.8	203.6
Panel B. Reduced form						
Sleeping sickness	0.183***	0.279***	0.000	0.073	-0.078	0.033
	(0.037)	(0.083)	(0.051)	(0.063)	(0.053)	(0.079)
Standardised β coefficient	0.120	0.093	0.000	0.032	-0.047	0.013
R^2	0.58	0.56	0.49	0.46	0.32	0.39
Observations	981	755	1,040	1,050	1,051	915
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
Panel C. 2nd stage						
Colonial settlement	0.431***	0.642***	0.001	0.170	-0.189	0.058
	(0.087)	(0.188)	(0.120)	(0.148)	(0.129)	(0.175)
Standardised β coefficient	0.266	0.206	0.000	0.069	-0.105	0.023
Anderson-Rubin p-value	0.000	0.000	0.995	0.242	0.129	0.733
R^2	0.53	0.50	0.43	0.36	0.13	0.29
Observations	981	755	1,040	1,050	1,051	915
Baseline controls	✓	✓	✓	✓	✓	✓
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓

Notes: The table presents the 2SLS estimates of equation (1). The sleeping sickness instrument is a dummy variable equal to one if the hospital is located within an area where the infection rate was least equal to 1% at any time during the 1929-1953 period. Baseline controls are those presented in panel A of Table 2. Robust standard errors are in parentheses. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 5: Early and late colonial settlement

Dependent variable:	Government transfer				Bed capacity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Colonial settlement	0.337***	0.430***	0.295***	0.419***	0.276***	0.275***	0.282***	0.267***
	(0.080)	(0.078)	(0.093)	(0.089)	(0.046)	(0.063)	(0.044)	(0.054)
× Early settlement		-0.147*				0.002		
		(0.082)				(0.053)		
× Late settlement			0.134				-0.020	
			(0.080)				(0.058)	
× Early religious mission				-0.131				0.014
				(0.087)				(0.049)
R^2	0.557	0.558	0.558	0.558	0.592	0.592	0.592	0.592
Observations	755	755	755	755	981	981	981	981
Baseline controls	✓	✓	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓	✓	✓
Province Fixed Effect	✓	✓	✓	✓	✓	✓	✓	✓

Notes: The unit of observation is a hospital. The table presents the OLS estimates. The dependent variables are government transfer and bed capacity, both taken in logarithm. Early settlement is a dummy variably equal to one if the colonial settlement was constructed before 1936 and 0 otherwise. Late settlement is a dummy variable equal to one if the settlement was built after 1945. Early religious mission is a dummy variable equal to one if the settlement was a religious mission prior to 1929 (without necessarily providing health services) and is reported as providing health services before 1936. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 6: Historical targeted population

Dependent variable:	Government transfer			Bed capacity		
	(1)	(2)	(3)	(4)	(5)	(6)
Colonial settlement	0.337***	0.377***	0.433***	0.276***	0.270***	0.282***
	(0.080)	(0.071)	(0.087)	(0.046)	(0.045)	(0.074)
× Colonial Europeans		-0.157			0.024	
		(0.136)			(0.050)	
× Colonial Congolese			-0.138			-0.008
			(0.103)			(0.062)
R^2	0.557	0.558	0.558	0.592	0.592	0.592
Observations	755	755	755	981	981	981
Baseline controls	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓
Province Fixed Effect	✓	✓	✓	✓	✓	✓

Notes: The unit of observation is a hospital. The table presents the OLS estimates. The dependent variables are government transfer and bed capacity, both taken in logarithm. Colonial Europeans is an indicator equal to one if the colonial health settlement had at least one unit providing health services to Europeans only. Colonial Congolese is an indicator equal to one if the colonial health settlement had at least one unit providing health services to Congolese. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 7: Historical and modern hospital ownership

Dependent variable:	Government transfer				Bed capacity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Colonial settlement	0.337***	0.435***	0.307***	0.307***	0.276***	0.329***	0.251***	0.255***
	(0.080)	(0.086)	(0.079)	(0.087)	(0.046)	(0.048)	(0.049)	(0.043)
× Colonial state		-0.208**				-0.109**		
		(0.087)				(0.051)		
× Colonial mission				0.087				0.062
				(0.110)				(0.051)
× Colonial private			0.123				0.113	
			(0.118)				(0.072)	
Colonial settlement	0.337***	0.419***	0.441***	0.308***	0.276***	0.277***	0.340***	0.239***
	(0.088)	(0.106)	(0.115)	(0.084)	(0.046)	(0.078)	(0.048)	(0.040)
× Public hospital		-0.132				0.020		
		(0.146)				(0.079)		
Public hospital		0.142				-0.222***		
		(0.118)				(0.042)		
× Faith-based hospital			-0.208				-0.138*	
			(0.148)				(0.068)	
Faith-based hospital			0.271***				0.297***	
			(0.096)				(0.033)	
× Private hospital				0.387				0.412**
				(0.285)				(0.166)
Private hospital				-0.543***				-0.038
				(0.183)				(0.042)
F-test joint significance		0.01	0.04	0.02		0.00	0.00	0.00
R^2	0.56	0.56	0.56	0.57	0.59	0.60	0.61	0.59
Observations	755	755	755	755	981	981	981	981
Baseline controls		✓	✓	✓		✓	✓	✓
Geographic controls		✓	✓	✓		✓	✓	✓
Province Fixed Effect		✓	✓	✓		✓	✓	✓

Notes: The table presents the OLS estimates of equation (1). Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 8: Colonial settlement and local aid

	Health aid	US health aid	Local aid	Chinese local aid
	(1)	(2)	(3)	(4)
Colonial settlement	0.069***	0.030	-0.195**	0.125*
	(0.024)	(0.020)	(0.084)	(0.064)
Standardised β coefficient	0.076	0.083	-0.068	0.037
R^2	0.16	0.12	0.55	0.77
Observations	1,064	1,064	1,064	1,064
Mean dep. var	0.78	0.03	2.17	3.52
Province Fixed Effect	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓

Notes: The unit of observation is the hospital. Health and US aid are dummy outcome variables respectively equal to one if a hospital receive health and US health aid, and zero otherwise. Local and Chinese aid outcomes are measures of the distance between the hospital and its closest aid project as geocoded from the DRC AIMS Geocoded Research Release. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 9: Colonial settlement: exploring additional channels

	ln(0.01 + Light)		Malaria risk		Ethnic power		Concessions in CFS		Local gov.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Colonial settlement	-0.075	-0.069	0.004	0.003	-0.012	-0.014	-0.010	-0.004	0.090
	(0.101)	(0.065)	(0.010)	(0.007)	(0.021)	(0.011)	(0.032)	(0.019)	(0.057)
Standardised β coefficient	-0.019	-0.018	0.012	0.009	-0.013	-0.014	-0.009	-0.004	0.015
R^2	0.62	0.78	0.30	0.61	0.61	0.88	0.58	0.79	0.94
Observations	1,092	1,092	1,092	1,092	1,086	1,086	1,086	1,086	1,086
Mean dep. var	0.32	0.32	0.21	0.21	0.23	0.23	0.64	0.64	3.28
Province Fixed Effect		✓		✓		✓		✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓	✓	✓	✓

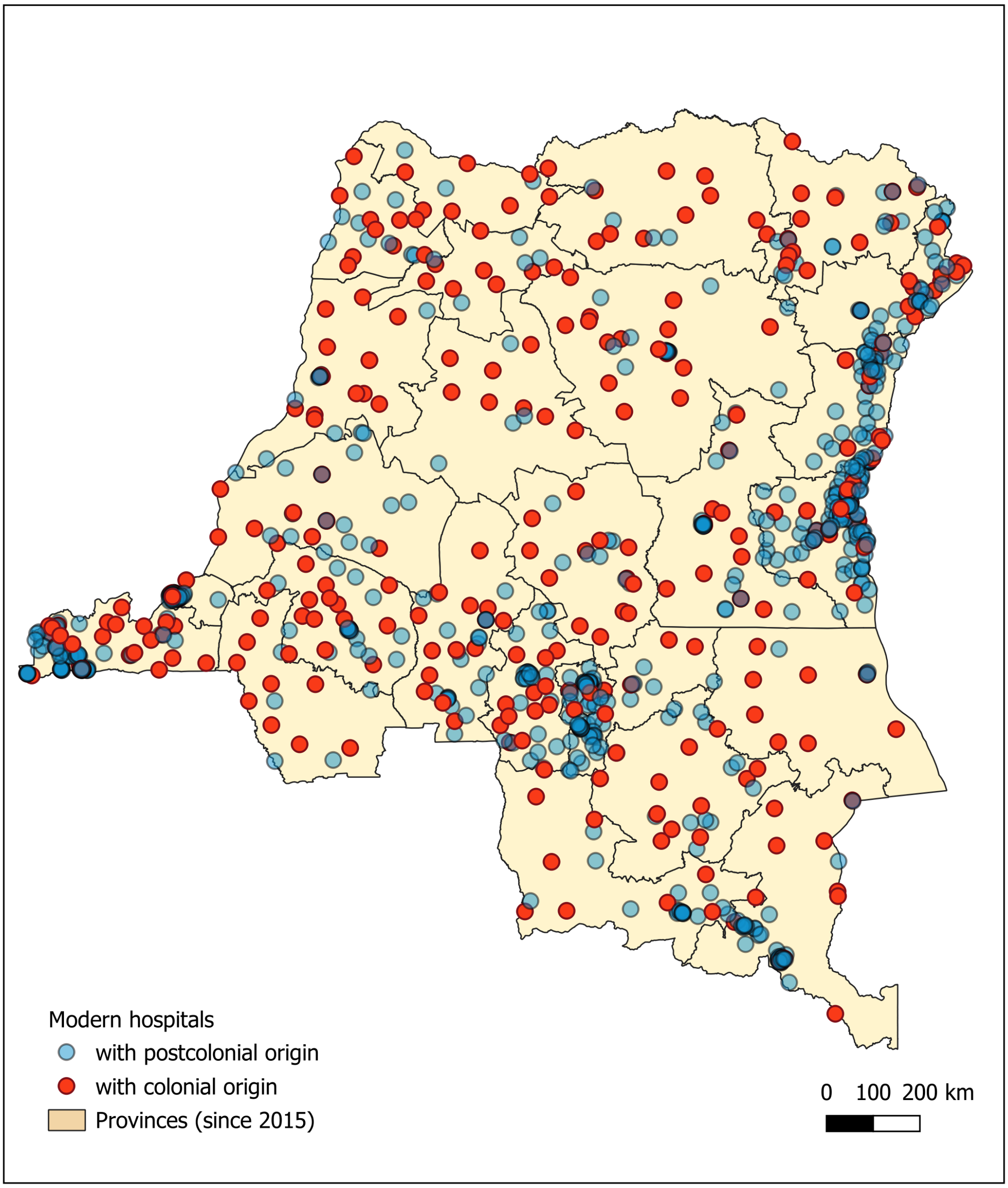
Notes: The table presents the OLS estimates of equation (1). The dependent variables are $\ln(1 + Light)$ to capture economic activity through nightlight, malaria risk, ethnic power, a dummy variably equal to one if a hospital is located in an area historically belonging to a private concession during the Congo Free State (CFS). The last dependent variable is defined as a dummy variable equal to one if the province governor was prosecuted for corruption interacted with the distance to the capital of the province to capture the influence of potential elite capture of government transfer. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table 10: Colonial settlement and government transfers

	Dep. Variable: Government transfers			
	(1)	(2)	(3)	(4)
Colonial settlement	0.332***	0.319***	0.256***	
	(0.083)	(0.083)	(0.083)	
ln(1+luminosity)	-0.031			
	(0.061)			
Aid		0.225*		
		(0.120)		
Bed capacity			0.365***	
			(0.086)	
Standardised β coefficient	0.106	0.102	0.083	
R^2	0.56	0.56	0.56	
Observations	755	755	731	
Baseline controls	✓	✓	✓	
Geographic controls	✓	✓	✓	
Province Fixed Effect	✓	✓	✓	
Mediation effect size	0.014	0.054	0.263	

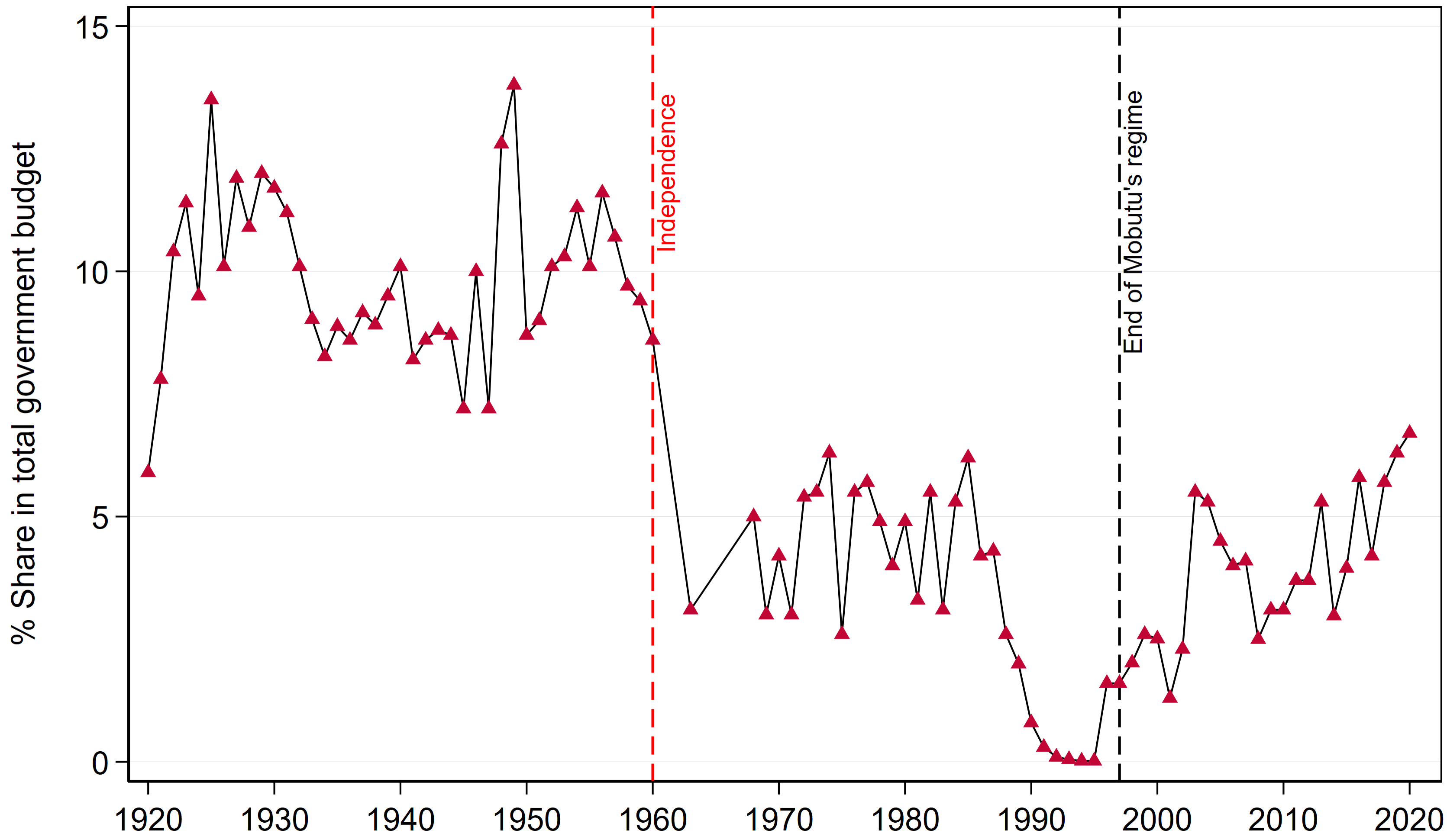
Notes: The table presents the OLS estimates of equation (1). Nondummy variables are in inverse-hyperbolic sines. The mediation effect size corresponds to the Sobel-Goodman mediation test that computes the proportion of the total effect of Colonial settlement that is mediated by aid, local resources, $\ln(1+luminosity)$, or ethnic political power. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Figure 1: Mapping of the full sample of colonial and post-independence hospitals



Notes: The map depicts the georeferenced locations of hospitals built during the colonial period between 1920 and 1956, and after independence in 1960.

Figure 2: Share of domestic health spending in total budget, 1920-2020

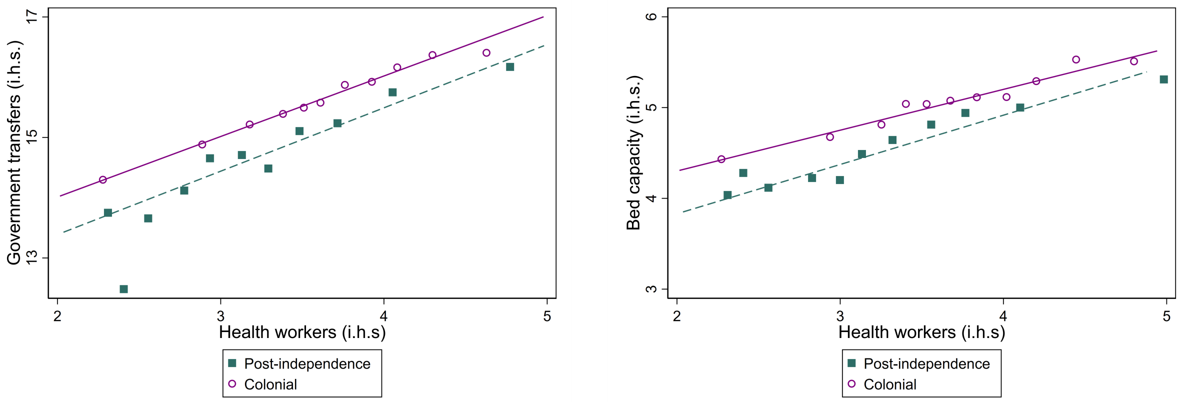


Notes: The graph plots the share of domestic health expenditure as a percentage of total government budget between 1920 and 2020. Counterparts funds received from donor grants, which are not voted budgets but managed by the government, are included in its budget. No information could be found for the immediate period following independence in 1960 (1961, 1962, and 1964 to 1967). *Source:* author's computations using *Annuaire statistique de la Belgique et du Congo Belge* and *Rapport annuel, Direction Générale des services médicaux du Congo Belge 1929-58* for the colonial period; World Bank and IMF data for the 1970-2000 period and Global Health Observatory data from WHO after 2000 (https://www.who.int/gho/health_financing/public_exp_health/en/) (see Appendix X for details on the data sources).

Figure 3: Communication channels in 1928

Notes: The map shows the communication channels organised in public services in 1928: railways (black), waterways (blue) and roads (red). *Source:* Institut Cartographique militaire Service Cartographique du Ministère des Colonies.

FIGURE 4: BINSCATTER PLOTS FOR THE EFFECT OF HEALTH WORKERS

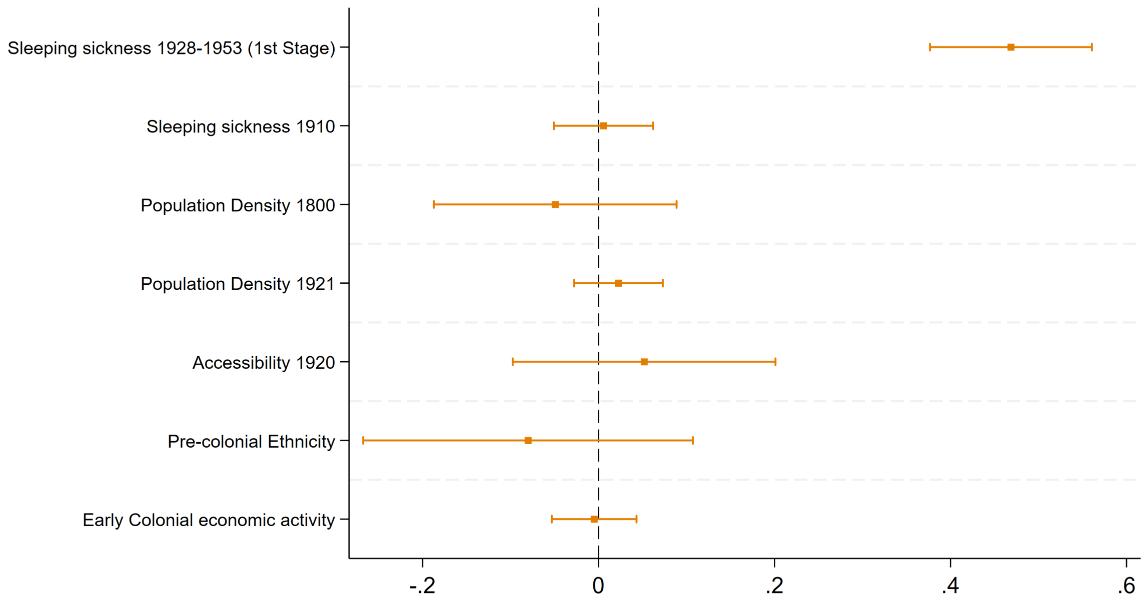


(A) Government funding

(B) Bed Capacity

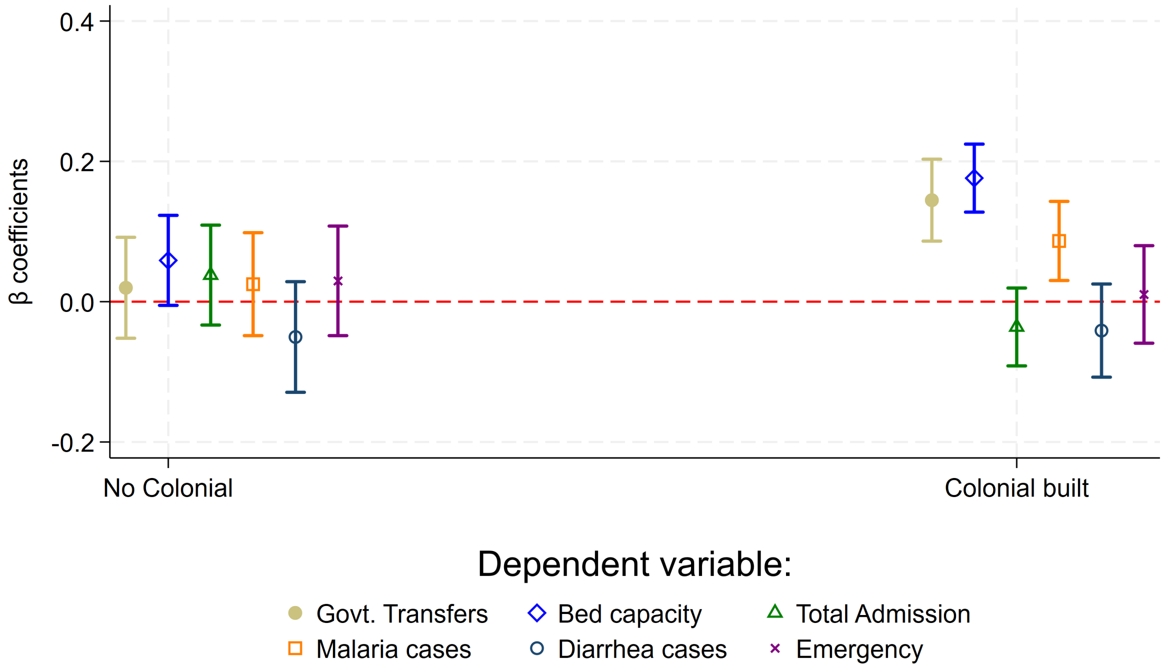
Notes: The graphs plot the binscatter plots for the correlation between health workers and government transfers (A), and health workers and bed capacity (B). All variables are transformed with the inverse hyperbolic sine. Solid (dash) fitted lines obtained from using regressions of health workers on the outcome for colonial (post-independence) hospitals, controlling for baseline controls and provincial fixed effects. We apply the covariate correction methodology proposed by Cattaneo et al. (2023) to calculate the integrated mean squared error-optimal number of bins.

FIGURE 5: FALSIFICATION TESTS



Notes: The graph plots the standardised coefficient estimates and 95% confidence intervals from OLS estimations of equation (2) with a range of alternative pre-1920 outcomes. Accessibility 1920 corresponds to the (logarithm) distance to the nearest transportation in 1920, pre-colonial ethnicity corresponds to ancestral characteristics of ethnic groups using the Ethnographic Atlas, coded by Murdock (1967) and updated by Nunn and Wantchekon (2011). Early colonial economic activity is a dummy variable equal to 1 if a hospital falls into an area that belongs to a concession granted to private companies under the Congo Free State (1885-1908). All regressions include provincial fixed effects as well as the baseline controls. Standard errors are clustered at the provincial level.

Figure 6: Reduced-form estimates of hospital outcomes on sleeping sickness



Notes: The graph plots the coefficient estimates and 95% confidence intervals of the effects of the distribution of sleeping sickness during the colonial period on the seven measures of hospital characteristics, in areas with no sleeping sickness (left) and with the disease presence (right).

Appendix for online publication

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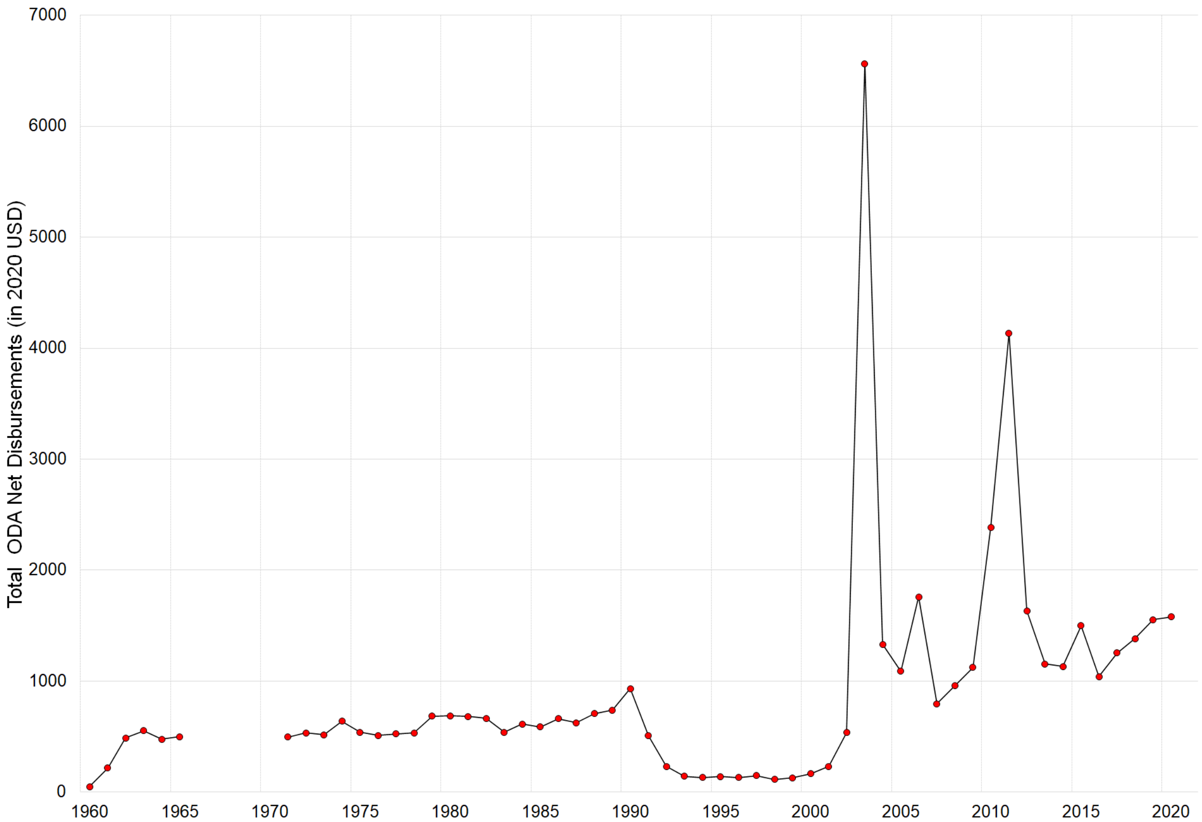
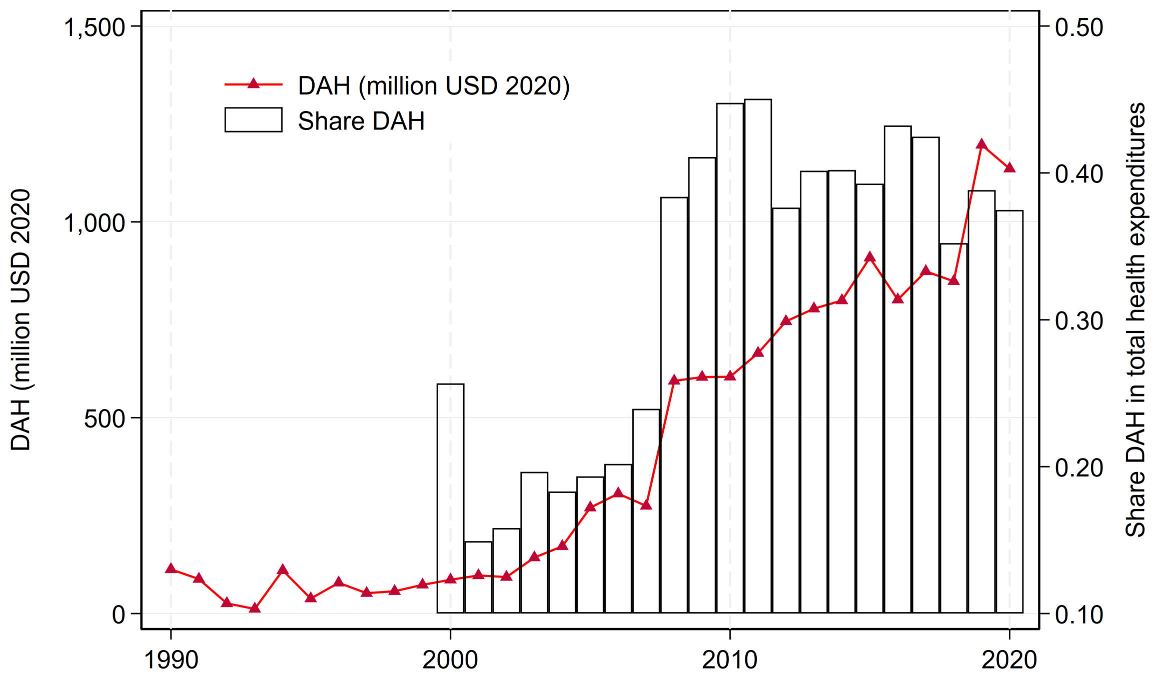
Figure A1: Total Aid disbursements in the DRC, 1960-2020



Notes: The graph plots the total disbursements of Official Development Assistance (ODA) between 1960 and 2020 in millions of 2020 USD in the DRC. ODA disbursements include loans made on concessional terms and grants by major bilateral aid donors to promote economic development and welfare. *Source:* OECD data (`https://stats.oecd.org/Index.aspx?DataSetCode=TABLE2A#`).

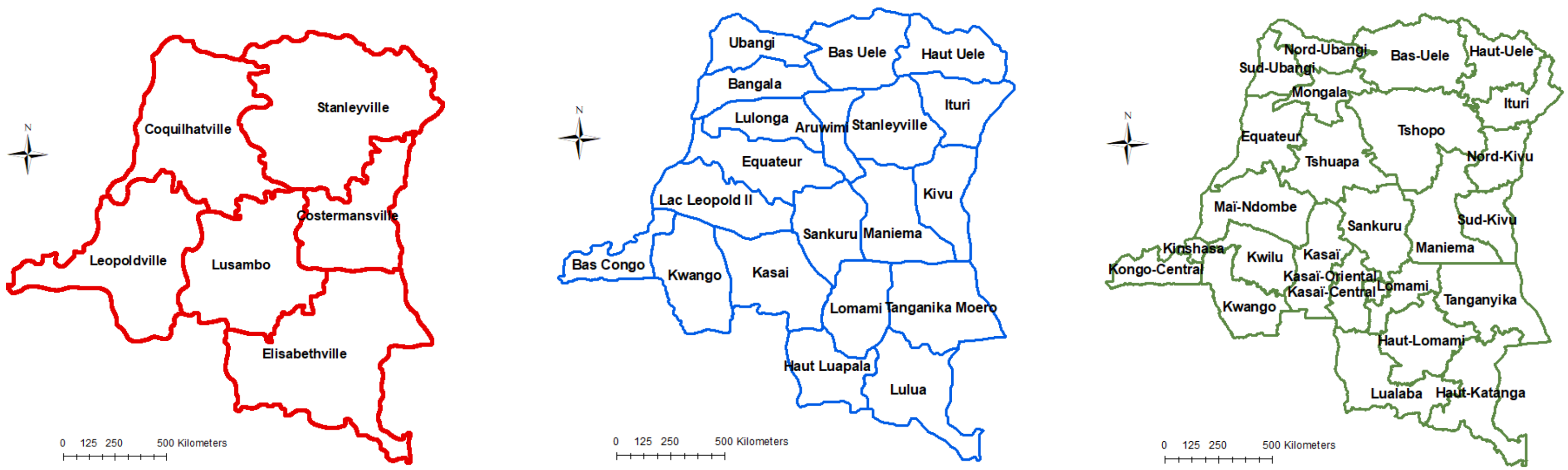
Figure A2: Development Assistance for Health in the DRC, 1990-2020



Notes: The graph plots the total Development Assistance for Health (DAH) between 1990 and 2020 in millions of 2020 USD in the DRC and its share in total health expenditure starting from 2004.
Source: author's computations using the Development Assistance for Health Database 1990-2020 from IHME Global Health Data Exchange (`http://ghdx.healthdata.org/`) and Global Health Observatory data from WHO (`http://apps.who.int/gho/data/node.home`).

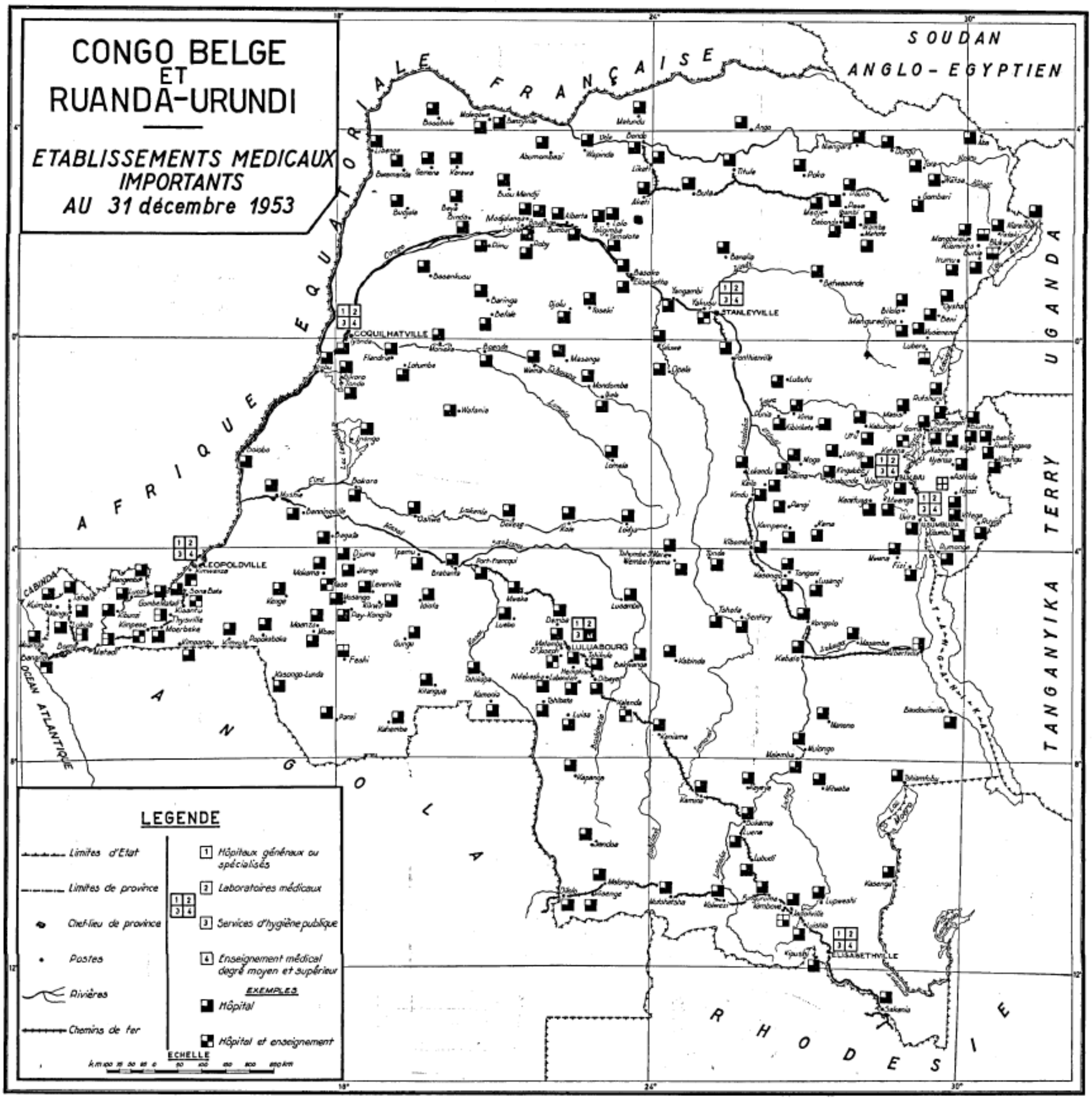
Figure A3: Administrative boundaries

(a) 1895 boundaries (provinces) (b) 1908 boundaries (districts) (c) 2015 provinces



Notes: The figures illustrate the evolution of the administrative boundaries in the Congo from the colonial period to the present day (since 2015). The Belgian Congo was divided into 6 provinces and 22 districts. Since 2015, the DRC is composed of 26 provinces that approximately correspond to the colonial districts, while most colonial names have been changed.

Figure A4: Mapping of colonial medical structures in 1953

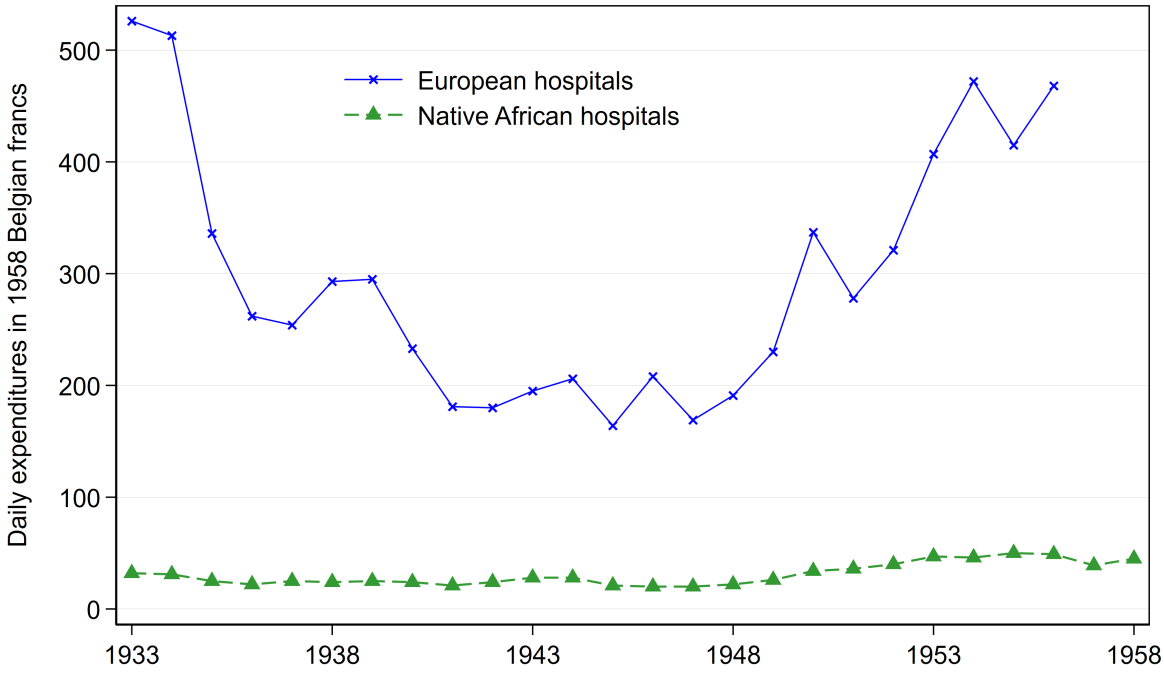


Notes: The map depicts the location of all major health infrastructures in 1953. *Source:* Ministry of Colonies.

Figure A5: Mapping of Christian missions in 1929

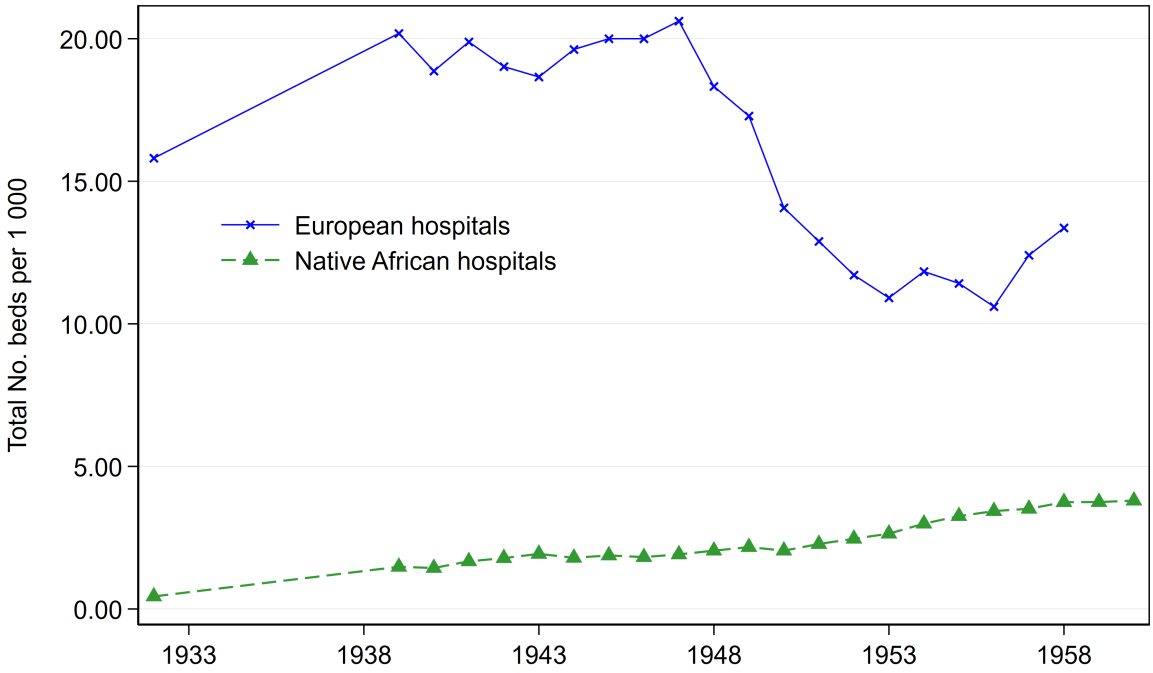
Notes: The map depicts the location of Christian missions (Catholics and Protestants) in 1929. *Source:* Ministry of Colonies.

Figure A6: Daily cost of European and native hospitals



Notes: The graph plots the country average daily cost (for the colonial government) of hospitalisation in European and native (dashed line) hospitals between 1933 and 1958. The estimated cost of hospitalisation includes health treatment costs, salary, provision of drugs and health equipment, and general maintenance costs. *Source*: Archival data from annual medical report in Belgian Congo for each year of the covered period.

Figure A7: Bed per capita between European and Congolese populations



Notes: The graph plots the shared of bed per capita for European (blue) and Congolese (dashed green line) hospitals between 1933 and 1958. *Source*: Archival data from annual medical report in Belgian Congo for each year of the covered period.

A Additional background information

A.1 Sleeping sickness

Ecology of the disease - Sleeping sickness, or Human Trypanosomiasis, is caused by a parasite and transmitted by the bite of a tsetse fly, the Glossina palpalis. This fly lives between forest and savannah, and uses wild game and domestic livestock as reservoir. Its usual habitat is low-lying bush and fringe along river systems. Sleeping sickness can rapidly spread from introducing an infected person into a suitable environment.

Sleeping sickness before colonial time - To some extent, Africans were aware of the risk of sleeping disease related to some particular places, and the danger related to displacements (Professor P.G Janssens). Africans were aware of the connection between ecology and disease. A standard practice among African societies was the isolation of suspected cases to protect the rest of the group.

The spread of the disease cannot be solely tracked through colonial activities, and rather depends on the spread of tsetse flies, migrations and internal displacements (Ford, 1971). This combination of factors affected the existing disease patterns among men and animals, which helped setting the stage for the sleeping outbreaks (Ford, 1971). The environmental changes induced by the colonial presence affected the ecological interplay between men, tsetse flies and parasites, and contributed to exacerbate the consequences on epidemiological outcomes. The quasi-randomly geographic spread of the epidemics was practically impossible to anticipate for the medical health authorities (Lyons, 2002).

Sleeping sickness during the colonial time - During the early 20th century, a succession of epidemics swept through equatorial Africa, drawing the attention of colonial powers to the disease. One notably severe outbreak occurred in 1901 on the shores and islands of Lake Victoria in Uganda, a region with a dense population. Between 1900 and 1920, a quarter of a million inhabitants succumbed to the illness in Uganda. Once confined to isolated pockets, the disease quickly escalated to epidemic levels across numerous regions.

The exact causes for the spread of the disease remain to this day unclear. Sleeping sickness likely had endemic status in the region, and its occurrence escalated into epidemics with the expansion of colonial influence, which amplified trade and migrations across Africa (Headrick, 2014). Factors closely related to the ecology of the disease involve the ecological settings, the habitat of the tsetse flies, the presence of wild and domesticated animals, and local socio-economic factors. Population displacement may increase the risk factor of the disease but fail alone to explain it (Ford, 1971). For instance, the incidence of the disease increased with imported labourers, often because the newcomers succumbed to harmful pathogens already present in the environment (Lyons, 2002). As a consequence of the increased movements of people and their pathogens, sleeping sickness spread along the rivers during the Congo

Free State period.

It was originally thought that the movements of people alone were the primary cause of the spread of sleeping sickness (Lyons, 2002). In response to the epidemic, the colonial administration sought to limit population movements to preserve the local labour forces. Before 1920, cases of suspected sleeping sickness were isolated in camps to monitor and control the spread of the disease, and regular checkpoints were established along the main roads and rivers to monitor the flow of people between infected and healthy areas. The colonial government further established a series of *lazarets* or sick camps for the infected, and *cordon sanitaires*, quarantine zones around fly-infested areas which severely restricted people's movements (Schwetz, 1946). Those diagnosed were forcibly confined and administered atoxyl, an arsenic-based treatment effective against trypanosomiasis, albeit with a risk of causing blindness (Lyons, 2002). Meanwhile, colonial demand for gold, rubber and labour forces intensified the movement of populations, directly contradicted public health regulations and aggravated the health crisis. As a consequence, the epidemic peaked during World War I, when many doctors were drafted to serve within the European military forces (Lyons, 2002).

In the following years, the medical authorities decided to move towards decentralised healthcare provision with mobile health teams sent to examine villagers in rural areas. The mobile teams, either under public health or religious authorities, contributed to open rural clinics, health centres and hospitals dedicated to the treatment of sleeping sickness, but also tuberculosis and leprosy (Lyons, 2002). By the end of the 1930s, the prevalence of the disease significantly declined in several parts of the country. Yet, medical authorities realised that they might fail to completely eradicate the disease, as the risk of sleeping sickness remained static in some areas despite a lack of systematic control efforts, and in other locations, the epidemic disappeared without any intervention (Trolli, 1932). Furthermore, mass treatments became increasingly unpopular, even among doctors, and growing concerns in the Belgian parliament about the level of expenditures on colonial medical service contributed to rationalise the therapeutic approach. A safer arsenic-based medication called tryparsamide was introduced, facilitating mass treatment of human cases and proving to be an effective method for controlling sleeping sickness. Complementary ecological, and locally diversified approaches were adopted, that focused on minimising human-fly contacts based on specific geographic locations (e.g brush clearing), and where local socio-economic factors were also recognised to influence endemicity and incidence (Lyons, 2002). The number of cases gradually declined in the following years to about 1000 cases in 1959 (Ekwanzala et al., 1996).

A.2 Health care organisation and personnel in the colony

In the early colonial period and until the end of the First World War, no formal medical organisation existed, little budget was devoted to health (less than 2%) and the provision of Western medicine was mostly limited to military and religious. While the role of military medical doctors was mainly to ensure the health of European expeditionary forces, religious missions aimed to provide health care to native populations (Au and Cornet, 2021). Later on, and upon agreements between religious organisations and the colonial state, religious missionaries were occasionally involved in the control of *lazarets* and isolation camps (Au, 2017).

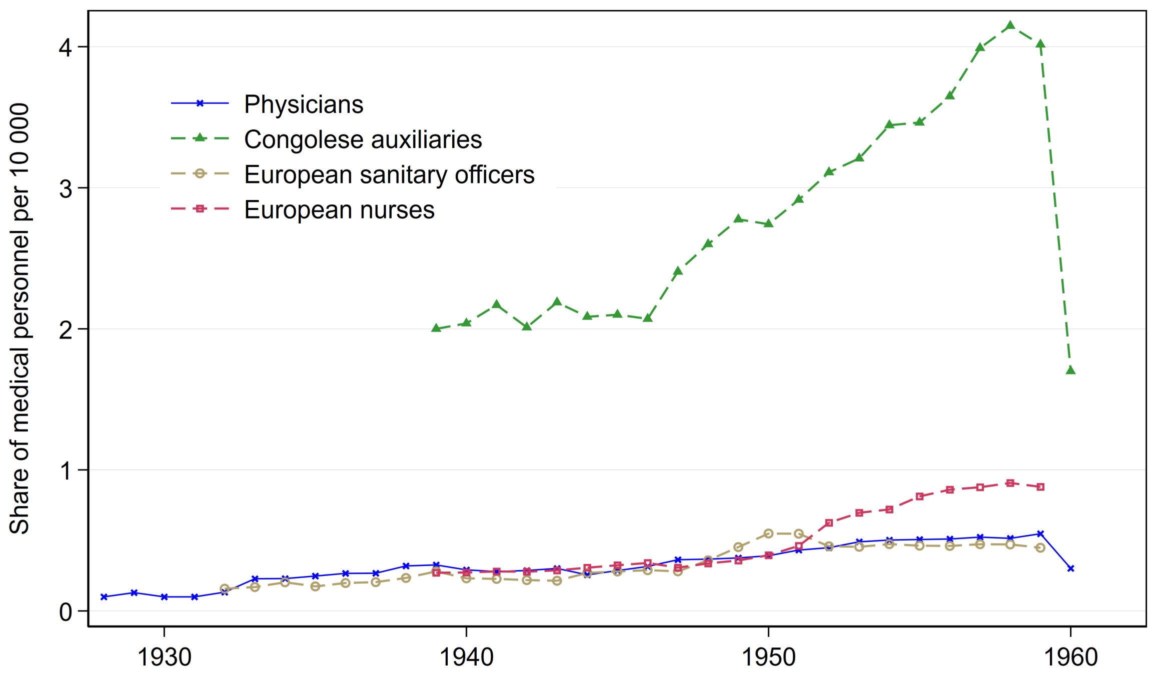
The spread of epidemics and the acceleration of economic exploitation in the colony spurred the need for a systematic organised approach to health care provision in the colony that would ensure a healthy workforce. By the interwar period, the provision of medical services began to expand with increasing numbers of state physicians (through regulation of working permits of foreign physicians and higher salaries), medical auxiliaries, and the multiplication of health infrastructure projects. At the same time, colonial authorities started to minimize the involvement of religious groups in state healthcare, favouring instead professionally trained medical personnel (Au, 2017). In 1922, a system of medical services is created to support the medical development of the Congo, with a transition from medicine for Europeans to medicine open to all native Africans. To better control and monitor the epidemics, alongside the physicians based near the administrative centres, the system of medical missions allocated mobile medical teams to small geographic areas. The medical teams were typically composed of Congolese medical auxiliaries supervised by a European *agent sanitaire* (sanitary officer). Within this territory, the teams carried out a six-monthly census of the population in order to monitor the evolution of endemic diseases, register births and deaths, and carry out immunization programs (Janssens, 1972). The training of medical auxiliary involved either an apprenticeship, or a one-year schooling program for those who obtained a certificate of elementary education (Janssens, 1972).

The chief medical officer (*médecin en chef*), based in the capital, supervised the provincial rural physicians (Janssens, 1972). Secondary positions were filled by physicians of the first and second class, who relied directly on local authorities to carry out their duties. Since European staff was too costly and scarce to manage all medical activities, colonial health authorities considerably increased the employment of African medical auxiliaries who remained subordinate to European personnel (Figure A8).

As colonial medical services grew, efforts were made to coordinate religious and charitable healthcare providers under the Charitable Native Medical Services (*Assistance Médicale Indigène Bénévole* or AMIB,). Through AMIB, the government furnished medications and equipment and increased financial support for salaries and operational costs to missions. In return, these missionaries offered assistance to the colonial health services, encompassing primary medical care in rural regions and the collection/reporting of medical data (Au and Cornet, 2021).

In parallel with the establishment of the colonial state and missionary healthcare provision, the private sector also initiated medical programs for the industrial workforce, driven by both the economic incentives of a healthy workforce and by legislation on labour protection. This resulted in a dual medical system operating concurrently: one managed by the government, and the other by religious missions or trading and agro-industrial companies. For instance, the Union Minière du Haut Katanga (UMHK) developed a comprehensive pyramidal medical framework for the early detection, isolation, and prevention of diseases through medical intervention at every level. This entailed establishing an extensive health infrastructure

Figure A8: Decomposition of medical personnel during the colonial period



Notes: The graph plots the decomposition of the share of medical personnel between physicians (blue), European nurses (red) and sanitary officers - *agent sanitaire* (brown), and Congolese medical auxiliaries (green). Medical auxiliary corresponds to assistant nurse. European nurses includes religious missionaries when they were reported to provide medical assistance. The *agent sanitaire* was in charge of mobile health teams in rural areas, under the supervision of a medical officer (Janssens, 1972). *Source:* author's computations using data on medical personnel and population estimates from *Annuaire statistique de la Belgique et du Congo Belge* and *Rapport annuel, Direction Générale des services médicaux du Congo Belge* for the colonial period.

to safeguard the well-being of the workforce, featuring dispensaries in mines, factories, and camps, hospitals with several hundred beds across various operational sites, and a central hospital equipped with state-of-the-art medical technology (Au and Cornet, 2021). Other major companies developed their own similar medical structure, such as the Compagnie du Kasaï, the Forminière, the Huileries du Congo belge, the Kilo-Moto gold mines, the Minière des Grands Lacs, Symétain, and Otraco.

The different and sometimes opposite objectives of the three actors resulted in geographical disparities in the allocation of health resources (Lyons, 2002).

Dispensaries, antenatal care and baby clinics, maternity hospitals and hospitals, leper houses, nurseries were part of the medical services provided by the state, religious missions or private firms. Nonetheless, populations continued to use both traditional and Western medicine, even towards the end of the colonial period (Au and Cornet, 2021).

A.3 Ten Year Plan

The Ten Year Plan was a public works programme between 1949 and 1959 that aimed to improve the general economic and social situations of the Belgian Congo, and stimulate thereby its economic development. The massive investment effort was made possible through the relatively low public expenditures combined with the continuing growth of the Congolese economy after World War II (Huge, 1955). The plan mostly relied on large public investment in the transportation sector (targeting air transport as well as the road, river and railway systems, representing about half of the total investment), agriculture and social services (housing, water supply, health, and education, accounting for approximately 25%). The health component of the plan included research on tropical diseases, medical campaigns, the development of health education and the construction of hospitals, clinics, and laboratories. The financing of the plan essentially relied on loans from Belgium, the United States and the International Bank for Reconstruction and Development.

A.4 After Independence

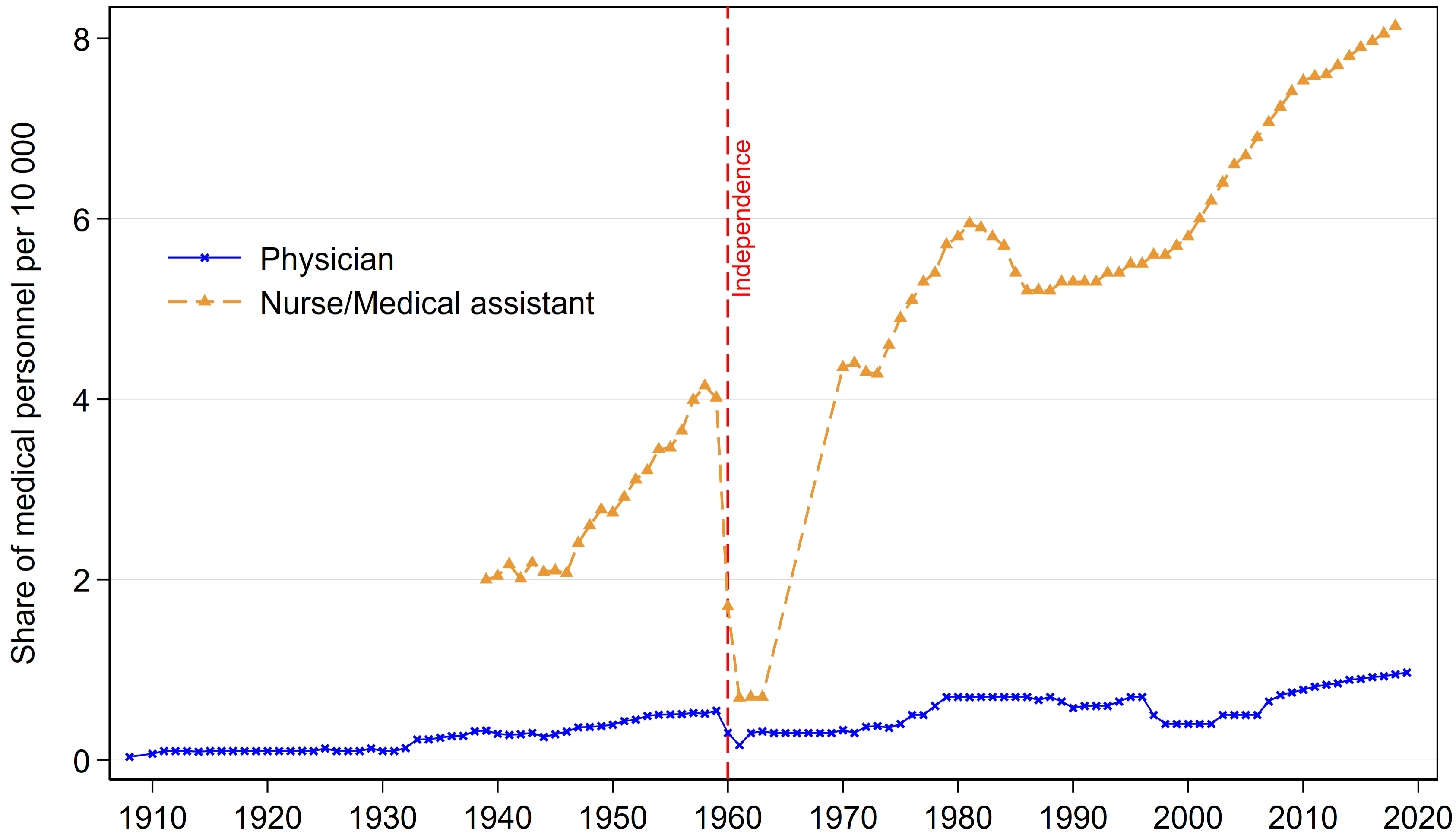
After the declaration of independence in July 1960, the conditions gradually deteriorated with the sudden exodus of European health personnel (Figure A9). At this time, there were no Congolese physicians (Mock et al., 1990). Disease control programmes were halted and population screening was significantly reduced, leading to a rapid surge in the number of sleeping cases (Ekwanzala et al., 1996). Yet, the number of cases stabilised during the first two decades of the post-colonial period. The health budget covered no more than low salaries of its employees, personnel recruitment and promotion were often based on patronage, and the quality of education provided by state health facilities considerably declined over the years (Mock et al., 1990). The breakdown of the healthcare system by the 1990s and the withdrawal of foreign aid contributed to the emergence of a new sleeping sickness epidemic, but also exacerbated new disease outbreaks, such as Ebola fever, dysentery, the plague, and cholera (Ekwanzala et al., 1996). However, a concerted effort between foreign donors and the national sleeping sickness control programme, as well as advances in curative treatment, have contributed to considerably reducing the burden of sleeping sickness, with only 953 cases in 2018 (Franco et al., 2020). The disease is now listed as a Neglected Tropical Disease, and the World Health Organization has set the objective to reach zero cases by 2030.[41]. Overall, the long-run evolution of the mortality rate suggests a steady improvement in population health (Figure A10 in Online Appendix) compared to the colonial era.

During the post-colonial period, healthcare services continued to be provided by the state, faith-based organisations, and the private sector. Yet, a long-standing underinvestment in the public health sector left most public hospitals with inadequate resources. Kornfield (1986) examines how the quality of healthcare provision varies with hospital ownership. Using Lubumbashi, the second largest city in the country, as a case study, the author states: "There were three hospitals in the city. The most fully staffed and adequately equipped was the private hospital run by the large mining company. It was run very much like an American hospital with strict visiting hours. Parents were not hospitalized with their children as the staff was sufficient to give the complete attention to sick infants. It served the employees

[41] https://www.who.int/news-room/fact-sheets/detail/trypanosomiasis-human-african-(sleeping-sickness)

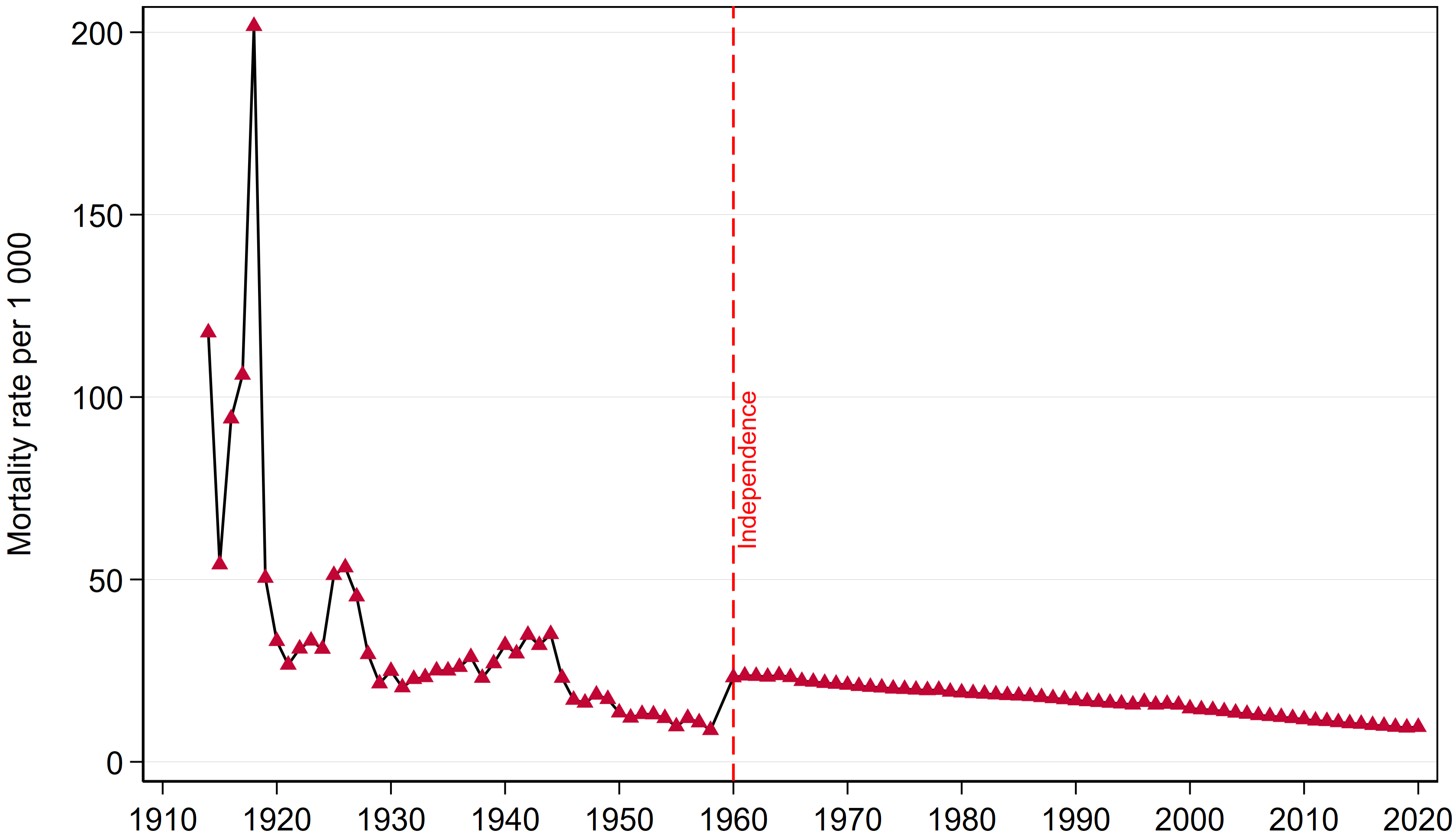
of the company and Zairian elite and Europeans. The least well-equipped and most inadequately staffed hospital which served the general population of the city was the public hospital run by the Zairian government. In this overcrowded hospital, families stayed with the patients, often slept on the floors of the hospital rooms, cooked their food, washed their laundry, and visited on the grounds within the inner court yard of the hospital buildings. The third hospital [...] was originally established by Catholic missionaries for the colonial community of the city. At the time of the study it served the university employees, including those professors and administrative staff who could not afford to use the mining company hospital, and those members of the population who could afford to pay for better care than was offered at the public hospital. It was better equipped than the public hospital but not as well as the mining hospital. The adequacy of its facilities and staff fell far below the minimum standards required of American and European hospitals".

Figure A9: Evolution of the share of medical personnel, 1908-2020



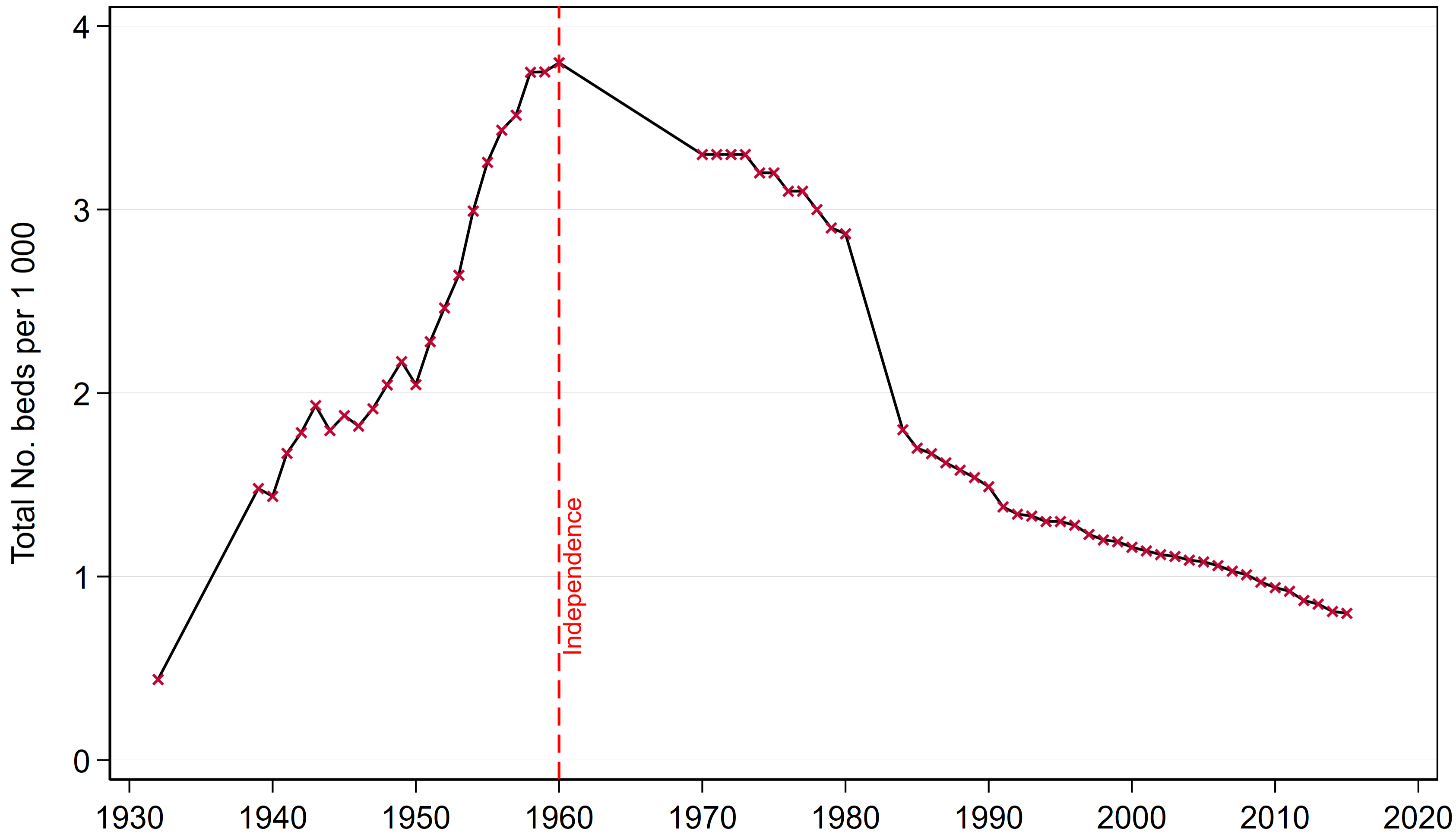
Notes: The graph plots the share of medical personnel (blue for physicians, orange for nurses) per 10,000 between 1908 and 2020. All numbers of medical personnel and population estimates were collected from the annual reports of public health in Belgian Congo during the colonial period, and from a combination of IMF, IBRD and World Bank reports in the post-colonial period. *Source:* author's computations using data on medical personnel and population estimates from *Annuaire statistique de la Belgique et du Congo Belge* and *Rapport annuel, Direction Générale des services médicaux du Congo Belge* for the colonial period; IMF, IBRD and World Bank reports in the post-colonial period (see Appendix X for details on the data sources).

Figure A10: Evolution of mortality rate, 1910-2020



Notes: The graph plots the evolution of the mortality rate per 1,000 among the Congolese population during the colonial period (1910-1960) and in the country in the post-colonial period (1960-2020). Data on mortality rate were collected from the annual reports of public health in Belgian Congo during the colonial period, and from a combination of IMF, IBRD and World Bank reports in the post-colonial period. *Source:* author's computations using data on medical personnel and population estimates from *Annuaire statistique de la Belgique et du Congo Belge* and *Rapport annuel, Direction Générale des services médicaux du Congo Belge* for the colonial period; World Bank estimates in the post-colonial period (Source:https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=CD (see Appendix B.1 for details on the data sources).

Figure A11: Evolution of bed capacity, 1930-2020



Notes: The graph plots the evolution of the total number of beds per 1,000 among the Congolese population during the 1930-2020 period. *Source:* author's computations using data on the Annual Medical reports of the Colony and population estimates from *Annuaire statistique de la Belgique et du Congo Belge* and *Rapport annuel, Direction Générale des services médicaux du Congo Belge* for the colonial period; World Bank estimates in the post-colonial period (`Source:https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=CD` (see Appendix B.1 for details on the data sources).

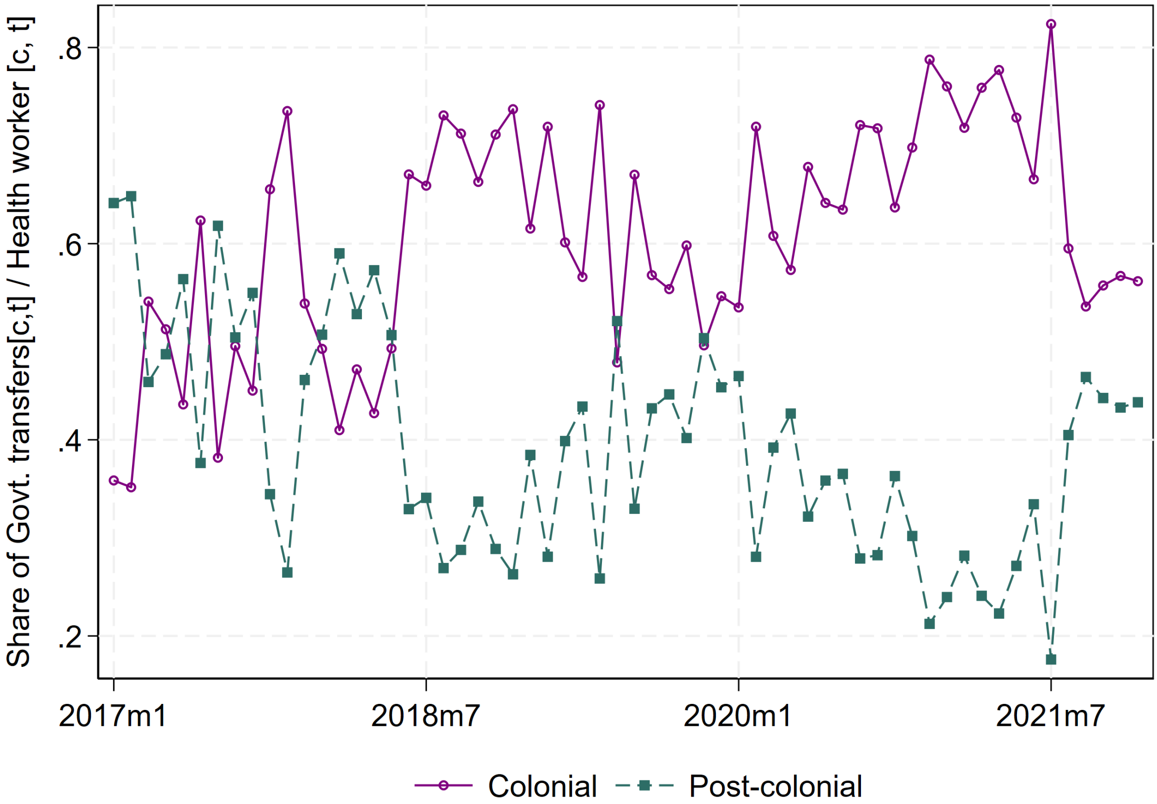
A.5 Contemporaneous health sector

The health system in DR Congo is made up of three levels: central, intermediate and peripheral. The peripheral or operational level is the health zone. Each health zone integrates a network of health centres (first line of care, e.g. providing only ambulatory care) around a general referral hospital (hospital of first resort). These two operational levels should function in a complementary way as an integrated system. Some rural health zones with limited access to a hospital also include referral health centres, which provide medical and surgical emergencies. The majority of non-hospital care is provided by the private sector, run mainly by health care professionals (nurses, doctors, etc.) who also own these care facilities (Chenge et al., 2010).

Health workers in hospitals are normally paid by the government, and their wage comprises a salary and occupational risk allowance (*prime de risque*). Only workers with a matriculation number can be enrolled in government payroll and receive a government salary. The risk allowance is not included in any enrolment scheme and is consequently allocated to a wider population of health staff. Low and delayed salary payments, and lack of risk allowance are frequent in the DRC (Bertone et al., 2016). For this reason, health workers also heavily depend on a local bonus paid by provinces, consultation fees (Maini et al., 2017), and donors' remuneration. The latter is a performance-based financing scheme which aims at motivating health workers and reducing absenteeism, but evidence suggests that donors' top-up payments may substitute with other income sources, i.e. fees and government salary (Fox et al., 2014; Bertone et al., 2016; Maini et al., 2017).

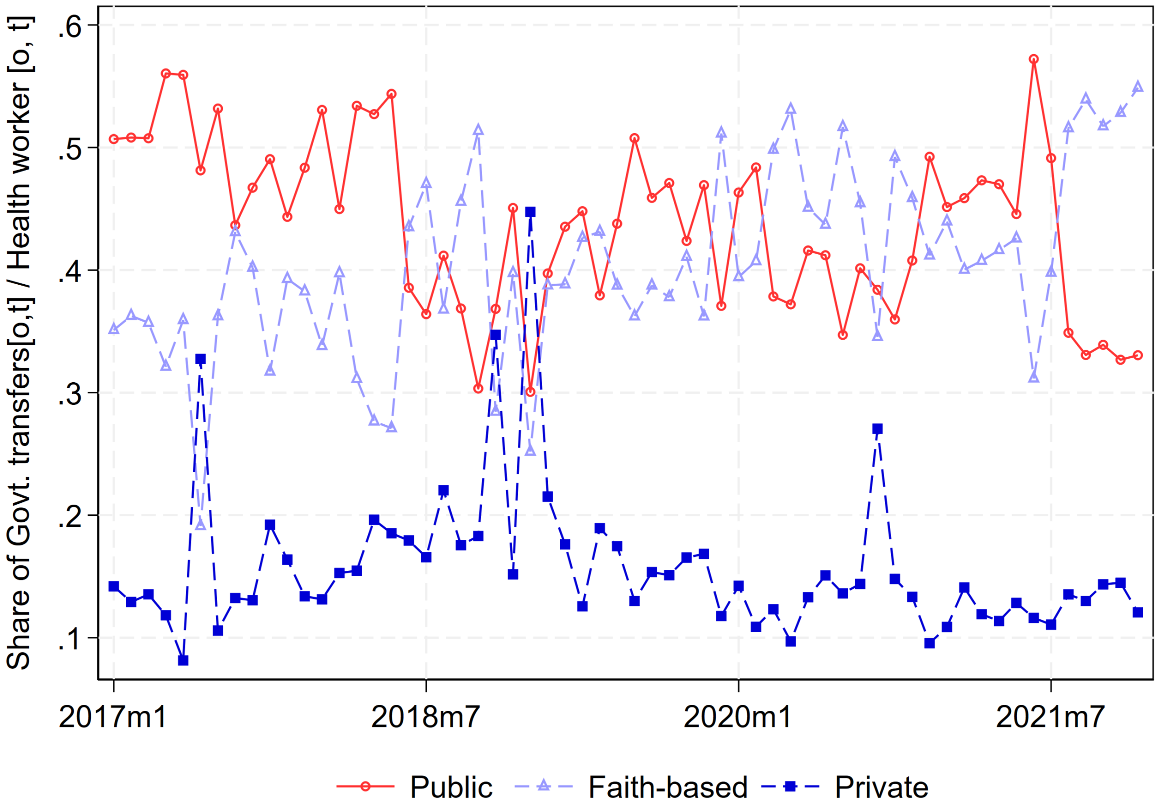
The private health sector plays an important role and includes large enterprises that provide in-house medical services, such as Gecamines, as well as private facilities that can be contracted with smaller businesses for their employees, or by individuals for curative care. The private pharmaceutical sector has an extensive network of both registered and unregistered facilities that often provide drugs without prescription; this network is supplemented by regional distribution centres organized into a federation (FEDECAME) that supply health products to public, private and faith-based facilities (Brunner et al., 2019). While there exist some private and community-based insurances, the vast majority of patients seeking care in the DRC are not covered by a health insurance scheme; fees for drugs and medicines are the primary driver for out-of-pocket expenditures (Laokri et al., 2018). The poorest individuals are more likely to seek care through traditional medicine and unlicensed pharmacies.

Figure A12: Share of government transfers between colonial and post-colonial hospitals



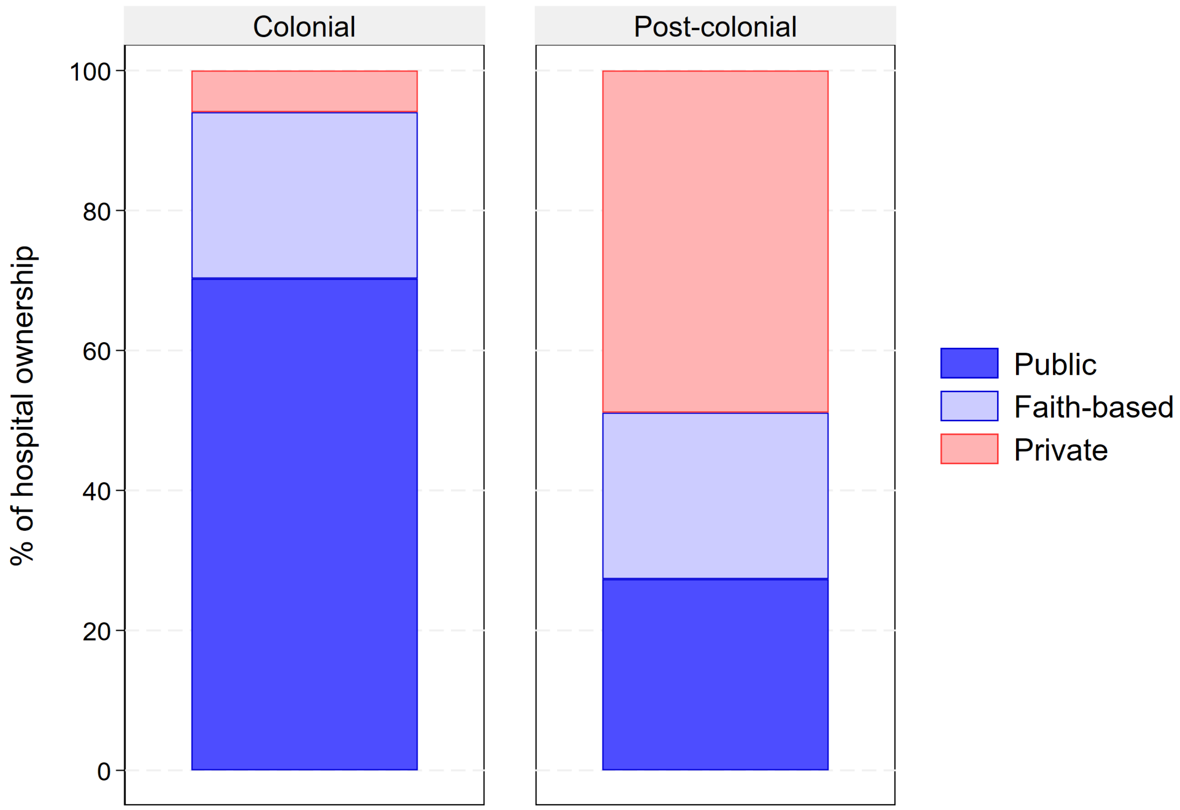
Notes: The graph plots the share of government transfers per health worker in hospitals c, in total government transfers per health worker at date t (year, month) in the country, and where c is the construction origin (colonial or post-colonial). The graph uses frequency weights to sum over observations with and without colonial origin at each date, and is restricted to public hospitals. The data spans the period between January 2017 and December 2021.

Figure A13: Share of government transfers across hospital ownership



Notes: The graph plots the share of government transfers per health worker in hospitals o, in total government transfers per health worker at date t (year, month) in the country, and where o is the hospital ownership (public, faith-based or private). The graph uses frequency weights to sum over observations with and without colonial origin at each date, and is restricted to public hospitals. The data spans the period between January 2017 and December 2021.

Figure A14: Share of hospital ownership between colonial and post-colonial hospitals



Notes: The graph plots the share of hospital ownership among hospitals with colonial and post-colonial ownership.

B Data Sources and variables definitions

B.1 Archival data

georeferenced locations of colonial health settlements and modern hospitals To construct a novel dataset of all geocoded colonial health settlements during the colonial period, we digitise and geocode colonial maps on health settlements between 1929 and 1959, 7 in total. These maps, produced by the Belgian Ministry of Colonies, provide information on the location of all hospitals and dispensaries that reported health activities to the colonial government.

We obtain the georeferenced locations of modern hospitals in the DRC primarily using DHIS2. Since the database provides incomplete information about the geographic coordinates of health facilities, we triangulated the geographic information of facilities from additional sources: ReliefWeb maps with detailed locations of health facilities in each of the 26 provinces in the DRC; the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) database, OpenStreetMap files and the International Committee of the Red Cross health maps.[42] ReliefWeb provides a list of geocoded health facilities in the DRC related to OCHA's humanitarian activities and OpenStreetMap is an open database routinely enriched by field observations, satellite images and integrated datasets. We supplement these maps with the location of health facilities supported by the International Committee of the Red Cross in 2018.

We then matched contemporaneous hospitals with colonial settlements based on the name of the facility and its geographic coordinates. As all hospital names with Belgian references changed after independence, we tracked all hospital names with a former Belgian name from multiple post-colonial sources to match the colonial names with modern hospitals (the most important source was from the following website: https://en.wikipedia.org/wiki/List_of_renamed_places_in_the_Democratic_Republic_of_the_Congo).[43]

Historical public finances

B.2 DHIS2 data

The DHIS2 (District Health Information System Version 2), is a health information system management developed, and supported by the University of Oslo (www.dhis2.org). The widespread implementation of the platform (more than 110 countries) is supported by global health partners such as the Global Fund, World Health Organization (WHO), UNICEF, USAID and GAVI, with the objective to strengthen Health Information System (HIS), and thereby inform evidence-based decision-making and strengthen health services delivery (Okonjo-Iweala and Osafo-Kwaako, 2007).

DHIS2 was first implemented in the DRC in 2013 at the national level. Routine data on key compo-

[42] These maps are obtained from the following websites: (ReliefWeb) https://reliefweb.int/; (OCHA) https://data.humdata.org/organization/ocha-dr-congo); (Red Cross) https://www.croixrouge-rdc.org/organisations/ and OpenStreet map (https://www.openstreetmap.org/).

[43] Using geographic location alone is insufficient as colonial maps only provide approximate geo-locations and new hospitals may have been built within a closed distance to colonial hospitals after independence.

Table A1: Maps of Belgian Congo

Document & Author	Year	Information
Administrative map, Goossens	1926	Administrative map
Institut cartographique militaire	1928	Communication channels
Religious missions map, Mission scientifique belge	1929	Religious missions
Annual Public Health report Belgian Congo	1933	map of sleeping sickness
Annual Public Health report Belgian Congo	1934	map of sleeping sickness
Annual Public Health report Belgian Congo	1934	Medical infrastructure
Annuaire des missions catholiques au Congo	1935	Colonial settlements
Annual Public Health report Belgian Congo	1935	Medical infrastructure (FOREAMI)
Annual Public Health report Belgian Congo	1936	Medical infrastructure
Annual Public Health report Belgian Congo	1936	map of sleeping sickness
Annual Public Health report Belgian Congo	1937	map of sleeping sickness
Annual Public Health report Belgian Congo	1938	map of sleeping sickness
Annual Public Health report Belgian Congo	1938	Medical infrastructure
Annual Public Health report Belgian Congo	1939	Medical infrastructure
Institut cartographique militaire	1939	Communication channels
Institut cartographique militaire	1940	Communication channels
Institut Géographique du Congo Belge	1946	Protestant missions
Annual Public Health report Belgian Congo	1947	map of sleeping sickness
Annual Public Health report Belgian Congo	1948	map of sleeping sickness
Annual Public Health report Belgian Congo	1948	Medical infrastructure
Institut Royal Colonial Belge, Index 624	1951	Population density
Annual Public Health report Belgian Congo	1952	map of sleeping sickness
Institut Royal Colonial Belge, Index 661.1	1953	Medical infrastructure
Institut Royal Colonial Belge, Index 663.2	1953	Map of Tse-tses
Institut Royal Colonial Belge, Index 622	1953	Nosological map
Institut Royal Colonial Belge, Index 622	1953	Mining concessions map
Institut cartographique militaire	1955	Missions protestantes
Institut géographique du Congo	1969	Map of mines and industries

Notes: Medical infrastructure refers to the geographic location of hospitals and health centres in Belgian Congo, along with their ownership (public, private, religious missions). Maps from Institut Royal Colonial Belge were collected from the Royal Academy for Overseas Sciences (https://www.kaowarsom.be).

nents such as health care programs, disease surveillance, stock management, finance, human resources, and infrastructure are collected at the health facility level. Additional information on a facility's catchment area is collected data on paper forms and transmitted to the facility by community health workers. At the end of each month, facilities send their routine data on key epidemiological, social, and financial indicators to the coordinating health zone office (*Bureau Central de la Zone de santé, BCZ*), and the paper forms are subsequently entered into the DHIS2 platform, managed and owned by the *Système National d'Information Sanitaire* (SNIS), of the Ministry of Health. The facility data are collected and analysed at the provincial level, and transmitted to the Ministry of Health to monitor the evolution of national programme outcomes, stock management, and disease surveillance. We cross-validate the self-reported data in the DHIS2 with estimates from external sources (IMF, World Bank, WHO) on the number of health workers, doctors, beds, and health aid. The matching of these estimates with the reported data in the DHIS2 at the national level gives further confidence in the accuracy of the database.

The following variables are extracted from the DRC DHIS2 (https://snisrdc.com/):

Table A2: Sources for Public health in Belgian Congo

Document	Year	Information
Annual Public Health report Belgian Congo	1932	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1933	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1934	Colonial settlements & public health spending
Annual Public Health report Belgian Congo	1935	Colonial settlements & public health spending
Annual Public Health report Belgian Congo	1936	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1937	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1938	Healthcare organisation & public health spending
Annual Public Health report Belgian Congoo	1939	Colonial settlements & public health spending
Annuaire des missions catholiques au Congo	1935	Colonial settlements & Healthcare organisation
Annual FOREAMI report	1935	Colonial settlements & Healthcare organisation
Annual Public Health report Belgian Congo	1940 - 1944	Colonial settlements & public health spending
Annual Public Health report Belgian Congo	1946	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1947	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1949	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1950	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1951	Colonial settlements & public health spending
Annual Public Health report Belgian Congo	1953	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1954	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1955	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1956	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1957	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1958	Healthcare organisation & public health spending
Annual Public Health report Belgian Congo	1959	Healthcare organisation & public health spending
Annual statistics: Medical missions	1938	Healthcare organisation & public health spending
Annual statistics: Medical missions	1946	Healthcare organisation & public health spending
Annual statistics: Medical missions	1947	Healthcare organisation & public health spending
Annual statistics: Medical missions	1948	Healthcare organisation & public health spending
Annual statistics: Medical missions	1949	Colonial settlements & public health spending
Annual statistics: Medical missions	1950	Healthcare organisation & public health spending
Annual statistics: Medical missions	1951	Healthcare organisation & public health spending
Annual statistics: Medical missions	1950	Healthcare organisation & public health spending
Annual statistics: Medical missions	1952	Healthcare organisation & public health spending
Annual statistics: Medical missions	1953	Colonial settlements & public health spending
Annual statistics: Medical missions	1954	Healthcare organisation & public health spending
Annual statistics: Medical missions	1955	Healthcare organisation & public health spending
Annual statistics: Medical missions	1956	Healthcare organisation & public health spending
Annual statistics: Medical missions	1957	Healthcare organisation & public health spending
Annual statistics: Medical missions	1959	Colonial settlements & public health spending

Notes: Colonial settlement refers to geographic information about a health settlement. Healthcare organisation refers to any information about the number of doctors, nurses, beds, European and Congolose populations, and the disease burdens in Belgian Congo reported by the public health authorities.

Population: Log of population in the catchment area of a hospital (approximately equal to district population) as reported in the DHIS2.

Government transfers: Funding allocated from the central government to a hospital, that is essentially used for payments of health worker salaries and occupational risk allowances. The amount is expressed in 2017 US Dollars, as a monthly average between January 2017 and December 2018.

Bed capacity: Total number of beds in a hospital as reported in the DHIS2.

Health workers: Total number of nurses working in a hospital, including A1 (nursing colleges with undergraduate degree), A2 (secondary level of nursing school (diploma)) and L2 (graduated with a 5 year university degree)levels.

Table A3: Documents collected on Public financing

Document	Year	Author	Publisher
Annuaire Statistique Congo Belge 1924-25	1927		Ministere Interieur et Hygiene
Le probleme economique au Congo Belge	1932	O. Louwers	Institut Royal Colonial Belge
Budget bill Congo Belge	1932		
Budget bill Congo Belge	1934		
Budget bill Congo Belge	1935		
Budget bill Congo Belge	1936		
Indices conjoncture économique du Congo Belge	1933	G. Eyskens	Bulletin de l'Institut de Recherches Économiques et Sociales
Le Congo économique	1938	J. Onckelinx	Bulletin de l'Institut de Recherches Économiques et Sociales
Le Congo Belge et la politique de conjoncture economique	1946	Van de Putte	Institut Royal Colonial Belge
La situation économique du Congo belge 1940-46	1948	M. Masoin	Bulletin de l'Institut de Recherches Économiques et Sociales
Bulletin de l'Institut de Recherches Économiques et Sociales	1949		
Situation économique du congo belge	1950		Etudes et conjoncture - Economie mondiale
Situation économique du congo belge	1953		Ministere des Colonies
Bulletin d'information et de documentation Congo Belge	1952		Banque Nationale de Belgique
Essai sur la zone monétaire belge	1954	C. Lefort	Revue économique
Budget bill Congo Belge	1954		
Economic planning and development in Belgian Congo	1955	J. Huge	Annals of the American Academy of Political and Social Science
Annuaire Statistique Congo Belge 1956	1957		Institut National de la Statistique
Rapport EA-77A Economy of Belgian Congo	1957		IBRD
Economie du Congo	1958		Bulletin de la Banque centrale du Congo belge et du Ruanda-Urundi
The economy of the Belgian Congo	1959	R. Bertieaux	Institut de Sociologie de l'Université de Bruxelles
La situation économique du Congo	1961	R. Bertieaux	Louvain Economic Review
La situation économique du Congo	1963	J. Lacroix	Louvain Economic Review
Sante Congo	1963		Mission assistance technique CEE Congo
L'Économie Congolaise 1960-65	1968	M. Norro	Institut de Recherches Economiques et Sociales
Rapport AF-23A Economie de la Republique du Congo	1964		IBRD
Blocage de la croissance economique en RDC	1967	H. Vander Eycken	Revue Tiers Monde
African Public Finances	1968	G. Martner	Latin American Institute for Economic and Social Planning
Situation Economique et Sociale Congo	1971	F. Bezy	IBRD
Rapport 821-ZR Economie du Zaire	1975		IBRD
Rapport 1407-ZR Economie du Zaire	1977		World Bank Archives
Rapport 2518-ZR Economie du Zaire	1979		World Bank Archives
Rapport 4077-ZR Economie du Zaire	1982		World Bank Archives
Rapport 5417-ZR Economie du Zaire	1985		World Bank Archives
Zaire population, Health, Nutrition	1989		World Bank Archives
Rapport 8995-ZR Zaire examen Depenses de l'Etat	1991		World Bank Archives
Zaire: Background information and Statistical data	1996		IMF country report
Zaire's hyperinflation 1990-96	1997	P. Beaugrand	IMF country report
DRC: : Poverty Reduction Strategy Paper	2003		IMF country report
DRC: : Poverty Reduction Strategy Paper	2004		IMF country report
DRC: : Poverty Reduction Strategy Paper	2007		IMF country report
DRC: : Poverty Reduction Strategy Paper	2010		IMF country report
DRC: : Poverty Reduction Strategy Paper	2011		IMF country report
DRC: : Poverty Reduction Strategy Paper	2013		IMF country report
DRC: : Poverty Reduction Strategy Paper	2015		IMF country report
Rapport 96172-ZR Revue de la gestion des depenses publiques	2015		World Bank
DRC Country report	2018		IMF country report
DRC Country report	2021		IMF country report

Notes: IBRD: International Bank for Reconstruction and Development; IMF: International Monetary Fund.

Physicians: Total number of general and speciality physicians in a hospital as reported in the DHIS2.

Total patients: Monthly average of total inpatients and outpatients between January 2017 and December 2018.

Malaria: Monthly average of severe malaria cases treated between January 2017 and December 2018. Severe malaria treatment relies on artesunate injection and differs from uncomplicated malaria treatment (artemisinin-based combination therapies).

Diarrhea: Monthly average of patients treated for diarrhea between January 2017 and December 2018.

Emergency: Monthly average of patients treated in the emergency department between January 2017 and December 2018.

Health aid: dummy variable that indicates whether a hospital receives medical or financial support from external sources, as reported in DHIS2.

B.3 Additional data

Distance to coast: The geodesic distance from each hospital to the nearest coastline measured in km. Colonial hospital locations are obtained from multiple maps from colonial archival data between 1929 and 1956. Examples of such maps are presented in figures A4 and A5.

Distance to transport: The geodesic distance from each hospital to the nearest transportation mode, which comprises railways, paved road and main rivers as navigation mode measured in km. The communication channels during the colonial period are obtained from a 1928 map on public services in Belgian Congo from the *Institut Cartographique militaire Service Cartographique du Ministère des Colonies* (see Online Appendix Figure 3). Additional information on transport connections from the International Bank for Reconstruction and Development IBRD (1957) supplements the mapping before independence in 1960. Euclidean distances are calculated with ArcGIS.

Natural resources: A dummy variable equal to one if a hospital is located within a geographic area that contains natural resources (gold, diamond, copper, tin, bauxite, coal, cobalt, iron, manganese, and uranium), as reported by the colonial administration (using the 1953 mining concessions map from the *Institut Royal Colonial Belge*, and after independence (with the 1969 map of mines and industries from *Institut géographique du Congo*).

Distance to electrical infrastructure: data on electricity infrastructure in the DRC obtained from a model developed in collaboration between the Energy Sector Management Assistance Program (ESMAP) at the World Bank, KTH Royal Institute of Technology, World Resources Institute (WRI), the University of Massachusetts Amherst and Facebook. The model combines night lights imagery collected from the Visible Infrared Imaging Radiometer Suite (VIIRS) band sensor on board the NASA Suomi satellite with GIS data on roads from OpenStreetMap and global land cover Moderate Resolution Imaging Spectroradiometer (MODIS).

Distance to the provincial city: The geodesic distance from each hospital to the main provincial city during the colonial period measured in km (Leopoldville, Costermansville, Albertville, Elisabethville, Stanleyville).

Distance to armed conflicts: The geodesic distance from each hospital to a civilian conflict (defined as political violence and protest). The data is obtained from the Armed Conflict Location and Event Data Project (ACLED) which reports georeferenced information on political violence and protests between January 2017 and December 2021.

Distance to Regional Distribution Centre: The geodesic distance from each hospital to the nearest Regional Distribution Centre (*Centrale de Distribution Régionale*, CDR). The 19 CDRs across the DRC supply public, private and faith-based health facilities with essential medicines and other pharmaceutical products. The list of CDRs in 2017 was obtained from the Department of Pharmaceuticals and Medicines (*Direction de la Pharmacie et du Médicament)*, Ministry of Health (`https://http://dpmrdc.org/BASE-DES-DONNEES`).

Malaria risk rate: indicator of the malaria parasite transmission intensity in 2017 obtained from the Malaria Atlas Project to account for the spatial heterogeneity of malaria transmission in the DRC. The *Plasmodium falciparum* parasite rate (PfPR) is an index of malaria transmission intensity which estimates the proportion of children aged 2 to 10 who carries the parasite (Hay and Snow, 2006). Annual median of PfPR in 2017 was obtained at approximately 5 km resolution from the Malaria Atlas Project (`https://map.ox.ac.uk`).

Ethnic Political Power: a dummy variable to indicate whether the ethnic group in the geographic area where a hospital belongs is politically active, with access to executive government power. Data was collected from the GROWup platform on settlement patterns of politically active ethnic groups developed by **girardin2015growup**. We code as dominant an ethnic group that has been dominant either during the Mobutu regime or at anytime since 1999, corresponding to the modern DRC period.

Light: nightlight data obtained from the NASA/NOAA Visible Infrared Imaging Radiometer Suite (VIIRS) sensor between 2018 and 2020.

Elevation: Data collected using satellite images obtained from the Shuttle Radar Topography Mission (SRTM). The data provide elevation information at the 30 arc-second resolution, corresponding to approximately to a cell of one square kilometer near the equator.

Slope: Calculated in degrees using information from the Shuttle Radar Topography Mission (SRTM)

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Historical population density: Population density during the colonial period using a digitised map on population density in 1921 from Trewartha and Zelinsky (1954), and a 1951 map from the Institut Royal Colonial Belge. we further collect data on population density in 1800 from the History Database of the Global Environment (HYDE) version 3.3

Ruggedness index: Terrain Ruggedness index using the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) version 3 (`https://lpdaac.usgs.gov/products/astgtmv003/`).

Soil suitability: Suitability of index for cassava, maize, and rubber collected from the Food and Agriculture Organization's Global Agro-Ecological Zones v4 model (FAO-GAEZ v4): `https://gaez.fao.org/`.

Development Aid: Geocoded aid projects reported by the government of the DRC Aid Information Management System (AIMS) between 1998 and 2014. The donors are the Department for International Development (UK), European Commission, KfW Bankengruppe, Embassy of Sweden, Embassy of Canada, Embassy of Japan, Embassy of Sweden, Embassy of Belgium, Embassy of Netherlands, Embassy of Germany, Korea International Cooperation Agency, USAID, World Bank, UNDP, Deutsche Gesellschaft Technische Zusammenarbeit, African Development Fund. Data collected from DRC AIMS Geocoded Research release, version 1.3.1, 2016.

Chinese Aid: Geocoded Chinese aid projects in the DRC, which correspond to loans and grants from official sector institutions in China. Data collected from AidData's Global Chinese Development

Table A4: Change in hospital ownership: past and present numbers

	1959		Actual	
Period:	No.	Share (%)	No.	Share (%)
Colonial hospitals				
Public	145	48.2	188	62.3
Faith-based	99	32.9	96	31.9
Private	57	18.9	17	5.6
Total	301		301	

Notes: The table shows the number of colonial hospitals in the data sample that changed ownership after independence. The table reports the number and share of hospitals by ownership right before independence (1959) and with actual data as reported from the DHIS2. Public, faith-based and private present-day ownerships correspond respectively to government, religious missions and private firms during the colonial period.

Finance Dataset, Version 3.0 (Custer et al., 2023).

Table A5: Lost colonial hospitals

	1959 No.	Actual No.	Share in total 1959 (%)
Panel A. Total recorded hospitals	408	301	73.8
Panel B. Hospitals lost after Independence			
Public		20	4.9
Faith-based		19	4.7
Private		22	5.4
Panel C. Lost hospitals			
Total recorded		61	15.0
Total unrecorded		46	11.3

Notes: The table presents the number and share of colonial hospitals recorded in the archives and in the modern list in panel A, and in panel B the hospital lost during the postcolonial period by ownership (government, religious missions and private firms). Panel C lists the number of colonial hospitals with a recorded georeferenced location in the archives and that could not be found in the modern list of hospitals. Panel C further reports the number of colonial hospitals whose georeferenced locations were not recorded in the archives (total unreported). This number is derived using the difference between the reported number of hospitals aggregated at the national level in the latest colonial archives (1959), and the latest georeferenced locations of colonial hospitals. Public, faith-based and private present-day ownerships correspond respectively to government, religious missions and private firms during the colonial period.

Table A6: Characteristics of colonial health investments

	Bed capacity	
	(1)	(2)
Population density 1951	0.110**	0.094**
	(0.044)	(0.044)
Distance Provincial capital	-0.095*	-0.078
	(0.051)	(0.047)
Distance to transport	-0.026	-0.026
	(0.034)	(0.034)
Distance to coast	-0.074	-0.072
	(0.291)	(0.243)
Natural resources (before 1960)	0.121	0.115
	(0.087)	(0.090)
Elevation	-0.000***	-0.000***
	(0.000)	(0.000)
Longitude	0.010	0.012
	(0.035)	(0.035)
Latitude	0.021	0.020
	(0.052)	(0.046)
Cassava suitability	0.000	0.000
	(0.000)	(0.000)
Ruggedness	-0.003	-0.003
	(0.003)	(0.003)
White European population	0.116	0.107
	(0.074)	(0.082)
Sleeing sickness	0.033	0.033
	(0.113)	(0.114)
Population density in 1921		0.032
		(0.189)
Population density in 1800		0.076
		(0.053)
Sleeping sickness in 1910		0.007
		(0.078)
Concessions in CFS		0.026
		(0.115)
R^2	0.36	0.37
Observations	295	295
Mean dep. var	4.41	4.41
Province Fixed Effect	✓	✓

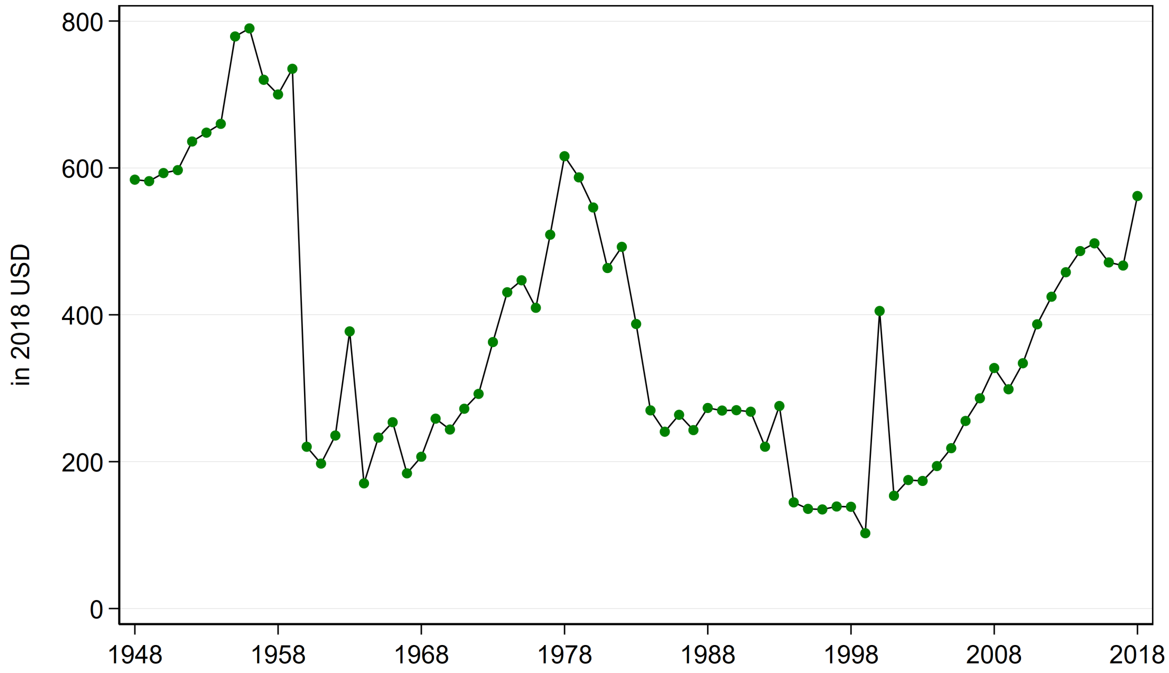
Notes: The unit of observation is a hospital. The table presents the OLS estimates. The dependent variable is bed capacity (in logarithm), a proxy for the amount of colonial health investment. The data sample is restricted to hospitals with a colonial origin. Natural resources is a dummy variable equal to one for the exploitation of natural resources during the colonial period. White European population is an indicator equal to one if the colonial health settlement had at least one unit providing health services to Europeans only. Colonial Congolese is an indicator equal to one if the colonial health settlement had at least one unit providing health services to Congolese. Concessions in CFS is a dummy variably equal to one if a hospital is located in an area historically belonging to a private concession during the Congo Free State (CFS). Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

C Long-run series of public finances

We build long-run series of the share of domestic health expenditures in the total budget, public revenue, and expenditure by drawing on numerous data sources for different sub-periods: during the colonial period, the series primarily relies on national reports of the Belgian Congo from Ministry of Economic and Financial Affairs, statistical yearbooks and bills containing the ordinary budget. In the post-independence period, data was mostly obtained from the International Monetary Fund (IMF), the World Bank, and the International Bank for Reconstruction and Development (IBRD) reports. Additional reports from the Central Bank of the Congo (Zaire) supplemented the data collection. A full description of these data sources is presented in Online Appendix Section B.1. We further cross-validate the data from the Colonial reports of the Belgian Congo with IMF, World Bank and IBRD reports to ensure that observed differences between the colonial and postcolonial periods are not driven by differing reported measures between the Belgian colonial administration and the international institutions. The novel data covers the period from 1920 to 2020, which allows to examine public finances from the inception of the health system in the colony to the end of the colonial period, the transition to independence, and the evolution until the modern period.

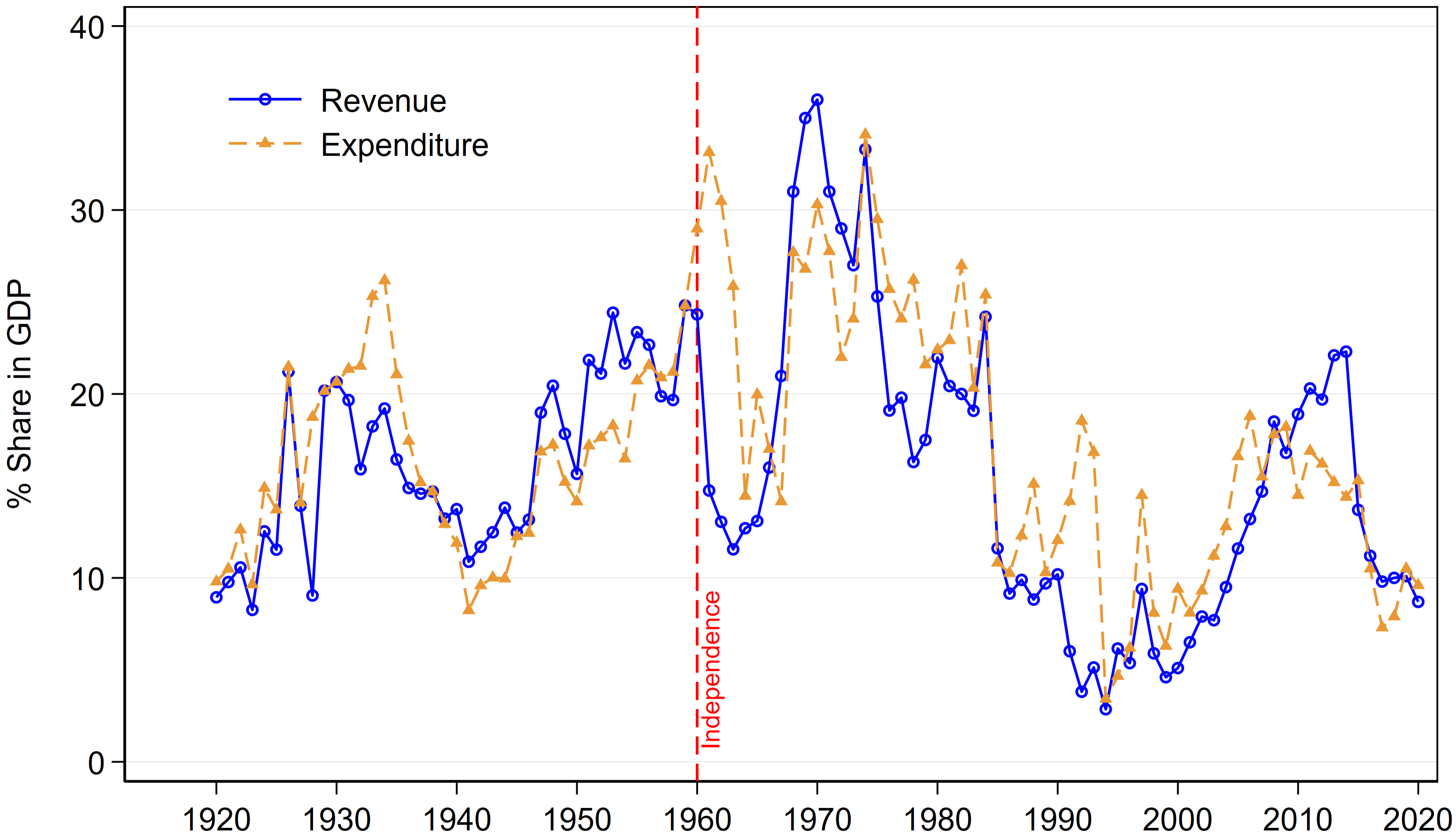
We further construct a series of Gross Domestic Product (GDP) using existing estimates for the 1920 - 1960 period from Eycken and Vorst (1967) and Lacroix et al. (1967), national accounts (Zaire and modern DRC), and IMF reports for the post-colonisation period.

Figure A15: DRC Gross National Income per capita in 2018 USD, 1948-2018



Notes: The graph plots the Gross National Income per capita of the DRC in 2018 USD between 1948 and 2018. *Source:* World Bank national account data (https://data.worldbank.org/indicator/NY.GNP.PCAP.CD).

Figure A16: Total government revenue and expenditure to GDP, 1920-2020



Notes: The graph plots the evolution of total government revenue and expenditure to GDP between 1920 and 2020. *Source:* author's computations using *Annuaire statistique de la Belgique et du Congo Belge* and *Rapport annuel, Direction Générale des services médicaux du Congo Belge 1929-58* for the colonial period; World Bank and IMF data for the post-independence period (see Appendix X for details on the data sources).

D OLS Results

D.1 Missing values and data quality

Our data on hospital outcomes were collected from hospitals reporting data as centralised in the DHIS2. A spurious relationship between colonial origin and government transfers could arise if colonial hospitals have a higher reporting rate, and better data quality. To address this possibility, Table (A17) in Online Appendix explores the association between colonial origin and two measures of data quality used by the Ministry of Health as dependent variables: completeness (the extent to which a minimum set of data is reported) and timeliness (whether data was reported within a given time period). It turns out that colonial origin has no effect on the completeness measure, and significantly reduces the timeliness of data reporting. Yet the latter is mostly explained by the over-representation of general referral hospitals, which due to their larger structure and wider range of service provided, may take more time to report their monthly data. When restricting the data sample to general referral hospitals (1), the colonial effect is no longer statistically significant.

Another concern is the relatively higher number of missing values in government transfers. The reporting platform does not allow for 0 value, and it may be that some facilities would actually report a 0 value. This concern should be limited by the fact that we collect data over 48 months, a long period for never receiving any government transfers. To partially address this concern, we interpolate missing information by using the measures of data quality, completeness and timeliness. As a benchmark, the DRC's national health information management set a minimum of 80% for each measure.[44] Online Appendix Table (A16) shows that the effect of colonial origin on government transfers remains relatively stable and statistically significant, although smaller and less precisely estimated as the number of interpolated data grows. We further characterise hospitals with non-reported government transfers, and show that they tend to be smaller, less exposed to malaria risk and conflict, and more concentrated in urban areas (Table A18). They are also less likely to have a colonial origin. Figure A23 documents the distribution of hospital ownership (public, faith-based, and private) between for hospitals with and without reported data on financial transfers. Reassuringly, two-thirds of hospitals with non-reported government transfers are private hospitals, for which transfers tend to be generally smaller (MSP, 2019). The share of private hospitals falls to less than 20% among facilities reporting transfers. This evidence strongly supports the view that underreporting may primarily be driven by weak incentives to report already low financial transfers. Table A19 interpolates missing values with different simulation exercises: unreported transfers data are replaced by the bottom 1% of the distribution for public hospitals in Column (2) and private hospitals in Column (3), with the top 1% for public hospitals and bottom 1% for private facilities in Column (4) and the reverse in Column (5). The Table documents a sizeable effect of colonial effect on government transfers across all specifications and reinforces our confidence that underreporting does not drive our results.

[44] https://dhis2.org/drc-data-use/.

Table A7: Colonial settlement and hospital outcomes: health worker polynomials

	Government transfers			Bed capacity		
	(1)	(2)	(3)	(4)	(5)	(6)
Colonial settlement	0.418***	0.417***	0.401***	0.296***	0.300***	0.293***
	(0.092)	(0.093)	(0.098)	(0.047)	(0.047)	(0.046)
Health workers	1.006***	0.980***	0.084	0.548***	0.759***	0.392
	(0.053)	(0.169)	(0.461)	(0.041)	(0.123)	(0.203)
Health workers^2		0.005	0.368*		-0.038	0.099
		(0.032)	(0.169)		(0.021)	(0.067)
Health workers^3			-0.044*			-0.015*
			(0.019)			(0.007)
Standardised β coefficient	0.133	0.133	0.128	0.181	0.184	0.179
R^2	0.51	0.51	0.51	0.59	0.59	0.59
Observations	755	755	755	971	971	971
Mean dep. var	14.25	14.25	14.25	3.95	3.95	3.95
Province Fixed Effects	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓

Notes: The table presents the OLS estimates of equation (1) with only government transfers and bed capacity as dependent variables. Health workers is defined as the number of recorded nurses. Nondummy variables are in logarithm transformation. All columns include the baseline controls except for the number of physicians. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A8: Colonial settlement and hospital outcomes: excluding health workers

	Government transfers		Bed capacity	
	(1)	(2)	(3)	(4)
Colonial settlement	1.133***	1.103***	0.704***	0.680***
	(0.124)	(0.118)	(0.065)	(0.062)
Standardised β coefficient	0.363	0.353	0.434	0.420
R^2	0.20	0.29	0.23	0.30
Observations	755	755	981	981
Mean dep. var	14.25	14.25	3.95	3.95
Province Fixed Effects		✓		✓
Geographic controls	✓	✓	✓	✓

Notes: The table presents the OLS estimates of equation (1) with only government transfers and bed capacity as dependent variables. The table replicates panel A of Table 2 with only excluding Health workers (nurses and physicians). Nondummy variables are in logarithm transformation. All columns include the baseline controls except for the number of physicians. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A9: Extended results of Table 2 panel B

Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Colonial settlement	0.276***	0.337***	-0.087**	0.156***	0.050	0.043
	(0.046)	(0.080)	(0.042)	(0.049)	(0.063)	(0.096)
ln Nurses	0.582***	0.583***	0.642***	0.544***	0.287***	0.686***
	(0.044)	(0.069)	(0.040)	(0.046)	(0.037)	(0.076)
ln Physicians	-0.041	0.621***	-0.006	-0.014	-0.004	0.010
	(0.054)	(0.078)	(0.044)	(0.064)	(0.055)	(0.101)
ln Distance Provincial capital	0.032	0.016	0.002	0.137	0.004	0.043
	(0.030)	(0.065)	(0.030)	(0.093)	(0.038)	(0.078)
ln Distance Distributional Centre	0.069**	0.141*	0.031	0.109**	0.044	0.087
	(0.029)	(0.072)	(0.022)	(0.045)	(0.033)	(0.061)
ln Distance Transport	0.004	-0.011	0.008	-0.009	0.027	0.002
	(0.016)	(0.029)	(0.020)	(0.035)	(0.020)	(0.039)
Population density 1951	0.041*	0.054	0.021	0.006	-0.009	0.030
	(0.020)	(0.053)	(0.035)	(0.067)	(0.031)	(0.048)
Natural resources (before 1960)	-0.165*	0.084	0.037	-0.000	0.007	0.040
	(0.093)	(0.111)	(0.113)	(0.112)	(0.122)	(0.134)
Malaria risk rate	0.144	0.475	-0.125	0.405	0.365	0.320
	(0.191)	(0.415)	(0.170)	(0.423)	(0.280)	(0.458)
Elevation	0.000***	0.000	-0.000*	-0.001***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln Population	-0.079	-0.201**	0.060	0.024	0.044	0.048
	(0.076)	(0.086)	(0.046)	(0.130)	(0.047)	(0.135)
Longitude	0.013	0.040	0.025	0.087**	0.049**	0.021
	(0.013)	(0.037)	(0.024)	(0.032)	(0.018)	(0.027)
Latitude	-0.004	0.080*	0.006	0.013	-0.036	-0.041
	(0.017)	(0.044)	(0.030)	(0.024)	(0.036)	(0.042)
ln Distance conflict	-0.019	-0.030	-0.030	-0.023	-0.027	-0.025
	(0.012)	(0.042)	(0.027)	(0.021)	(0.027)	(0.033)
ln Distance nearest hospital	0.025**	0.017	-0.007	0.084***	0.016	0.075**
	(0.011)	(0.043)	(0.012)	(0.022)	(0.018)	(0.032)
Hospital ownership	0.058**	-0.117*	0.043**	-0.030	-0.002	0.005
	(0.021)	(0.062)	(0.020)	(0.028)	(0.014)	(0.045)
Standardised β coefficient	0.171	0.108	-0.045	0.063	0.028	0.017
R^2	0.59	0.56	0.49	0.46	0.32	0.39
Observations	981	755	1,040	1,050	1,051	915
Province Fixed Effect	✓	✓	✓	✓	✓	✓

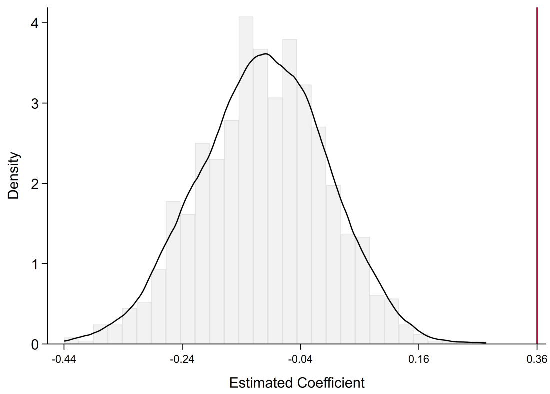
Notes: The table reports the estimated coefficients on the control variables in Panel B of Table 2. Nondummy variables are in inverse-hyperbolic sines. Robust standard errors are in parentheses. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A10: Colonial settlement and hospital outcomes: subsample robustness

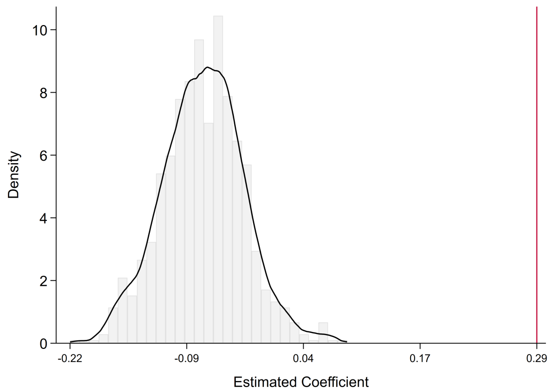
Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Panel A.			subsample: **Excluding Kinshasa**			
Colonial settlement	0.258***	0.336***	-0.095**	0.131**	0.022	0.014
	(0.047)	(0.080)	(0.045)	(0.049)	(0.062)	(0.098)
Standardised β coefficient	0.163	0.110	-0.052	0.056	0.013	0.006
Mean dep. var	3.95	14.22	5.60	3.37	1.35	3.45
R^2	0.62	0.55	0.52	0.50	0.35	0.41
Observations	910	734	936	945	945	850
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
Panel B.			subsample: **Excluding North & South Kivu**			
Colonial settlement	0.290***	0.262***	-0.080	0.147**	0.106*	0.071
	(0.052)	(0.082)	(0.050)	(0.055)	(0.057)	(0.099)
Standardised β coefficient	0.183	0.088	-0.042	0.063	0.062	0.030
Mean dep. var	3.92	14.37	5.63	3.36	1.27	3.38
R^2	0.57	0.57	0.47	0.47	0.33	0.41
Observations	776	603	842	847	846	728
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
Panel C.			subsample: **Excluding Ituri**			
Colonial settlement	0.282***	0.331***	-0.084*	0.165***	0.063	0.051
	(0.048)	(0.084)	(0.044)	(0.051)	(0.066)	(0.102)
Standardised β coefficient	0.172	0.107	-0.043	0.067	0.035	0.020
Mean dep. var	3.94	14.26	5.63	3.30	1.32	3.43
R^2	0.59	0.57	0.49	0.47	0.32	0.39
Observations	934	718	993	1,003	1,004	870
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
Panel D.			subsample: **Excluding Kasaï Oriental & Kasaï Central**			
Colonial settlement	0.307***	0.325***	-0.097*	0.147**	0.041	0.075
	(0.042)	(0.089)	(0.047)	(0.054)	(0.065)	(0.098)
Standardised β coefficient	0.190	0.105	-0.050	0.061	0.023	0.029
Mean dep. var	3.96	14.30	5.65	3.31	1.32	3.46
R^2	0.59	0.57	0.50	0.47	0.33	0.39
Observations	893	668	950	957	961	828
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓

Notes: The table reports the OLS estimates of equation (1), with alternative samples. Panel A removes hospitals from Kinshasa province, panel B excludes hospitals from North and South Kivu provinces, panel C from Ituri province, and panel D from the Kasaï region. Nondummy variables are all in natural logarithms. Baseline controls are listed in Table 2. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Figure A17: Permutation tests at hospital level



(a) Government funding



(b) Bed Capacity

Notes: The graphs plot the histograms with the distribution of coefficients obtained from permutation tests based on 1,000 replications, for government funding and bed capacity respectively at the top and bottom panel. The permutation inference is obtained by reassigning the colonial status of hospitals with an equal number of randomly drawn hospitals in the DRC. The vertical line indicates the estimated coefficient from the real assignment in the baseline sample (Table 2).

Table A11: Robustness to alternative standard errors

	Government transfers	Bed capacity
	(1)	(2)
Colonial settlement	0.350***	0.293***
	(0.087)	(0.049)
Inference Robustness (β)		
p-value: Robust S.E.	0.000	0.000
p-value: Wild Bootstrap	0.001	0.000
p-value: Moran I Test	0.272	0.258
Standardized β coefficient	0.112	0.180
Province Fixed Effects	✓	✓
Baseline controls	✓	✓
R^2	0.558	0.590
Observations	755	981

Notes: The table presents the OLS estimates of equation (1) with government transfers and bed capacity as dependent variables. The unit of observation is a hospital. Robust standard errors are in parentheses. The table reports p-value with robust standard errors clustered at the province level, wild bootstrap with 9,999 replications clustered at the province level p-value, and the p-value of Moran's I statistics for spatial autocorrelation. Bed capacity is the total number of beds. Nondummy variables are in logarithm transformation. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A12: Robustness to different cutoff radii for spatial clustering

Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Baseline: cluster by province						
Colonial settlement	0.276***	0.337***	-0.087**	0.156***	0.050	0.043
	(0.046)	(0.080)	(0.042)	(0.049)	(0.063)	(0.096)
Standardised β coefficient	0.171	0.108	-0.045	0.063	0.028	0.017
R^2	0.59	0.56	0.49	0.46	0.32	0.39
Observations	981	755	1,040	1,050	1,051	915
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
Standard errors: Spatial correction using correction thresholds						
100 km	(0.047)***	(0.080)***	(0.042)**	(0.061)**	(0.062)	(0.091)
150 km	(0.045)***	(0.082)***	(0.049)*	(0.055)***	(0.066)	(0.091)
200 km	(0.050)***	(0.081)***	(0.046)*	(0.058)***	(0.077)	(0.095)
250 km	(0.057)***	(0.068)***	(0.046)*	(0.051)***	(0.072)	(0.099)
500 km	(0.060)***	(0.060)***	(0.047)*	(0.043)***	(0.071)	(0.101)
750 km	(0.046)***	(0.054)***	(0.043)**	(0.042)***	(0.082)	(0.122)

Notes: The unit of observation is a hospital. The table presents the OLS estimates. Following Conley (1999) and using the approach developed by Colella et al. (2018), standard errors are adjusted for spatial dependence by clustering observations within circles of varying distances. The first panel reports the coefficient of the colonial settlement from equation 1 and the second panel reports the standard errors when changing the variance-covariance matrix through varying the distance thresholds of the spatial clusters. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A13: Colonial settlement and hospital outcomes: adding hospitals without lcoations

Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Panel A. Baseline sample						
Colonial settlement	0.334***	0.390***	-0.100**	0.297***	0.074	0.124
	(0.062)	(0.070)	(0.045)	(0.066)	(0.059)	(0.107)
Standardised β coefficient	0.206	0.125	-0.051	0.121	0.041	0.049
R^2	0.57	0.55	0.49	0.37	0.30	0.37
Observations	981	755	1,040	1,050	1,051	915
Baseline controls	✓	✓	✓	✓	✓	✓
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Geographic controls	X	X	X	X	X	X
Panel B. Adding hospitals with no recorded locations						
Colonial settlement	0.355***	0.434***	-0.113**	0.323***	0.113	0.159
	(0.063)	(0.067)	(0.047)	(0.063)	(0.066)	(0.113)
Standardised β coefficient	0.207	0.135	-0.050	0.120	0.059	0.058
R^2	0.55	0.54	0.51	0.38	0.31	0.37
Observations	1,180	783	1,296	1,301	1,302	1,086
Baseline controls	✓	✓	✓	✓	✓	✓
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Geographic controls	X	X	X	X	X	X

Notes: The unit of observation is a hospital. The table presents the OLS estimates. Panel A reports the estimates using the main data sample, and without controlling for the geographic factors. Panel B reports the results with no geographic controls and including hospitals with unknown geo-coordinates. Robust standard errors are in parentheses. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A14: Colonial settlement and government transfers (extended)

Dependent variable:	ln(Government transfer)		
	(1)	(2)	(3)
Colonial settlement	0.337***	0.344***	0.262**
	(0.080)	(0.077)	(0.131)
Nurses	0.583***	0.582***	0.696***
	(0.069)	(0.069)	(0.111)
Physicians	0.621***	0.620***	0.626***
	(0.078)	(0.078)	(0.130)
Oster δ for $\beta = 0$		-1.04	3.31
Standardised β coefficient	0.108	0.110	0.087
R^2	0.56	0.56	0.78
Observations	755	755	513
Mean dep. var	14.252	14.252	14.251
Hospital clusters	26	26	254
Province Fixed Effects	✓	✓	✓
Baseline controls	✓	✓	✓
Additional controls		✓	✓
Province-Share HW Fixed Effects			✓

Notes: The table presents the OLS estimates of equation (1) with only government transfers as dependent variable. All specifications control for health workers, hospital ownership, local population, and baseline geographic covariates. Additional controls include distance to electrical infrastructure, slope, and distance to coast. Oster δ refers to the test of the relative importance of observed and unobserved variables in selection bias, as suggested in Oster (2019). Nondummy variables are in inverse-hyperbolic sines. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A15: Colonial settlement and bed capacity (extended)

	(ln) Bed capacity (OLS)			Bed capacity (Poisson)		
	(1)	(2)	(3)	(4)	(5)	(6)
Colonial settlement	0.276***	0.277***	0.223***	0.249***	0.249***	0.201***
	(0.046)	(0.047)	(0.059)	(0.045)	(0.045)	(0.058)
Nurses	0.582***	0.581***	0.606***	0.629***	0.629***	0.611***
	(0.044)	(0.044)	(0.053)	(0.039)	(0.038)	(0.055)
Physicians	-0.041	-0.041	-0.075	-0.083	-0.083	-0.102**
	(0.054)	(0.054)	(0.054)	(0.052)	(0.052)	(0.051)
Oster δ for $\beta = 0$		-2.57	3.82			
R^2	0.59	0.59	0.81			
Observations	981	981	747	981	981	747
Mean dep. var	3.947	3.947	3.944	67.291	67.291	66.223
Standardised β coefficient	0.171	0.171	0.142	0.002	0.002	0.002
Province Fixed Effects	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
Additional controls		✓	✓		✓	✓
Province-Share HW Fixed Effects			✓			✓

Notes: The table presents the OLS estimates of equation (1) with only bed capacity as dependent variable. All specifications control for health workers, hospital ownership, local population, and baseline geographic covariates. Additional controls include distance to electrical infrastructure, slope, and distance to coast. Oster δ refers to the test of the relative importance of observed and unobserved variables in selection bias, as suggested in Oster (2019). Nondummy variables are in inverse-hyperbolic sines. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A16: Government transfers and missing values

	Government transfers			
	(1)	(2)	(3)	(4)
Colonial settlement	0.337***	0.330***	0.362***	0.277*
	(0.088)	(0.098)	(0.136)	(0.161)
Quality threshold				
Completeness score $\geq$		80%	80%	80%
Timeliness score $\geq$		80%	65%	50%
Standardized β coefficient	0.108	0.091	0.071	0.045
Province Fixed Effects	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓
R^2	0.557	0.466	0.371	0.406
Observations	755	758	769	780

Notes: The table presents the OLS estimates of equation (1), replacing the missing values in the dependent variable (government transfers) according to various assumptions about the data quality. When the reporting data from a hospital reaches a minimum quality threshold, missing values are replace with zero. The quality of data reporting is defined as reaching minimum threshold for completeness (how much of the expected data has been reported) and timeliness (whether a hospital has submitted the data within a certain period), two scores that are used to assess data quality by the central health system in the DRC that collects all hospital data. The minimum set objective by the central health authorities is 80% for both completeness and timeliness scores. Column (1) corresponds to the baseline results. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A17: Completeness and timeliness scores

	Completeness		Promptness	
	(1) All	(2) HGR only	(3) All	(4) HGR only
Colonial settlement	0.667	0.533	-2.592**	-0.103
	(1.712)	(1.574)	(1.010)	(0.261)
Standardised β coefficient	0.012	0.012	-0.072	-0.017
R^2	0.14	0.49	0.23	0.41
Observations	1,064	478	1,064	478
Province Fixed Effect	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓

Notes: The table presents the OLS estimates of equation (1) where the dependent variable is completeness score in Columns (1) and (2), and timeliness score in Columns (3) and (4). Columns (1) and (3) include all hospitals, and columns (2) and (4) restrict to referral general hospitals (HGRs). Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A18: Summary statistics for unreported govt. transfers

	Non-missing values			Missing values			Difference-in-means	
	Obs.	Sample mean	s.d.	Obs.	Sample mean	s.d.	Diff-in-means	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Colonial hospital	796	0.32	0.02	597	0.06	0.01	-0.26	0.00
Nurses	795	2.56	0.03	566	2.31	0.04	-0.25	0.00
Physicians	783	1.10	0.03	553	1.03	0.04	-0.07	0.18
Public hospital	796	0.50	0.02	597	0.17	0.02	-0.33	0.00
Faith-based hospital	796	0.43	0.02	597	0.25	0.02	-0.18	0.00
Private hospital	796	0.16	0.01	597	0.63	0.02	0.47	0.00
Distance to provincial city	767	5.11	0.04	328	3.84	0.11	-1.27	0.00
Distance to distribution centres	767	4.37	0.04	328	3.47	0.07	-0.89	0.00
Access	767	2.96	0.05	328	2.09	0.07	-0.87	0.00
Population density 1951	765	2.44	0.03	327	2.95	0.06	0.51	0.00
Presence natural resouces	768	0.47	0.02	329	0.57	0.03	0.10	0.00
Malaria risk rate	768	0.23	0.01	328	0.17	0.01	-0.06	0.00
Elevation	768	773.13	17.24	328	733.12	29.89	-40.02	0.25
Population	796	12.27	0.02	593	12.50	0.02	0.23	0.00
Longitude	768	23.49	0.18	329	21.21	0.36	-2.27	0.00
Latitude	768	-3.23	0.14	329	-5.00	0.20	-1.76	0.00
Distance to conflict	767	2.52	0.05	328	1.54	0.06	-0.97	0.00
Distance to electrical infrastructure	767	2.52	0.06	328	2.06	0.08	-0.45	0.00
Slope	768	1.17	0.02	328	1.17	0.04	-0.01	0.88
Distance to coast	767	6.88	0.02	328	6.92	0.02	0.04	0.13

Notes: The unit of observation is health facility and all financial characteristics are expressed in 2018 U.S. Dollars. All indicators correspond to monthly average numbers. The first six columns show the number of observations, sample mean and standard deviation for hospitals with and without missing values for government transfers. The last two columns indicate the difference in means between the two hospital groups, and the *p*-value of the test of whether the mean coefficients in the two samples are equal.

Table A19: Government transfers and missing values

	Government transfers				
	(1)	(2)	(3)	(4)	(5)
Colonial settlement	0.344***	0.278**	0.461***	0.378***	0.482***
	(0.087)	(0.112)	(0.101)	(0.109)	(0.128)
Interpolated data					
Public hospitals		bottom 1%		top 1%	bottom 1%
Private hospitals			bottom 1%	bottom 1%	top 1%
Standardized β coefficient	0.110	0.076	0.098	0.078	0.113
Province Fixed Effects	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓
R^2	0.561	0.429	0.644	0.560	0.274
Observations	755	795	926	960	960

Notes: The table presents the OLS estimates of equation (1), replacing the missing values in the dependent variable (government transfers) according to various simulations. Column (1) reports the baseline results. Columns (2) and (3) replace the missing values for respectively public and private hospitals with the bottom 1% of the transfers distribution. Columns (4) and (5) alternatively replace the missing values with the top 1% and bottom 1% of the distribution. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

E Matching procedure

The matching procedure imputes counterfactual observations by pairing colonial hospitals with their nearest post-independence neighbours from a predefined set of matching covariates, and exploits the large size of the control group (post-independence) relative to the treatment group (colonial hospitals). To reduce heterogeneity, we impose exact matching on the type of hospital (referral vs non-referral).

Spatial matching should ensure that matched hospitals share similar geographic characteristics and, consequently, address the concern that colonial settlements are located in areas with better geographical access or better climatological and epidemiological conditions (or conversely, some hospitals could operate under more adverse environmental factors). The matching procedure offers the possibility to ensure that hospitals in both colonial and post-independence groups operate under similar constraining factors.

The identification and consistency of the estimate rely on two assumptions: i) Unconfoundedness or random assignment of the treatment (*i.e.* the exposure to the treatment is independent of the outcome variable conditional on all relevant characteristics to the probability of treatment being observed) and ii) common support (or overlap) assumption, whereby the probability of being both a colonial or a post-independence hospital given a set of observable covariates should be positive.

We argue that both assumptions should be valid in this exercise. Although the location of colonial settlements might be motivated by several factors that include geographic characteristics, the exact location of a medical mission at a sufficiently small geographic level should also bear a randomised component. The favourable conditions that could motivate a settlement decision such as the proximity to a transportation mode, the economic activity of the area or the burden of disease among the local population locally form a continuum of location points with pre-defined characteristics of interest. The optimal location site of a hospital is then unlikely to be unique and should bear a random component. The colonial settlement should not preclude the construction of hospitals in its vicinity if the geographical area of optimal conditions is sufficiently large, or the population density is high enough.[45] The existing public infrastructures during the colonial period might also have opened up additional possibilities of locations for new hospitals and increased, thereby, the area of potential construction sites.

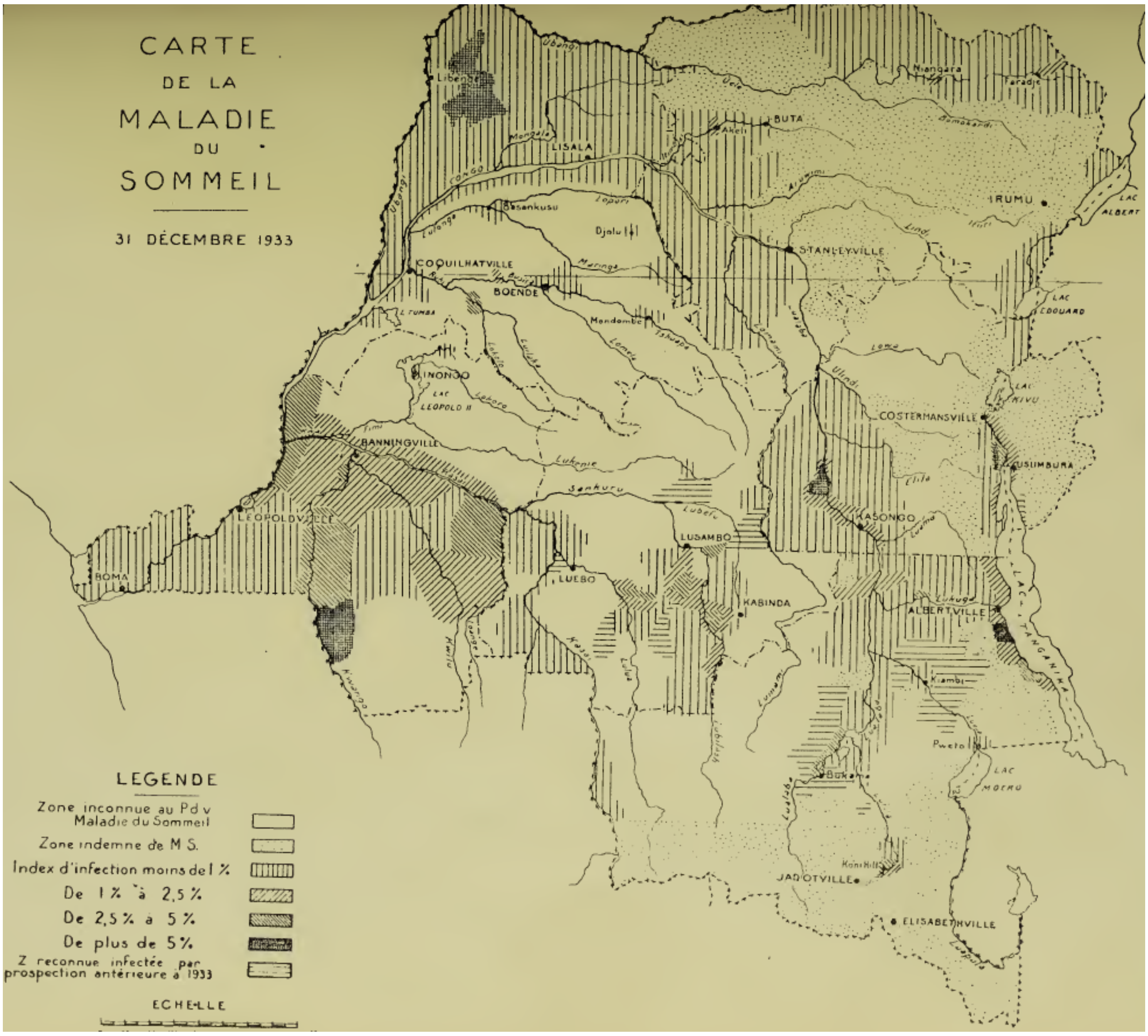
In other words, the overlap assumption may become invalid in the case where a colonial hospital is located in an area that presents few geographic comparabilities with bordering areas and its population is sufficiently low to deter the construction of new health facilities. Although these conditions are unlikely to hold in the highly populated DRC, I check this possibility in the following subsection by restricting the data sample to small geographic areas around colonial hospitals.

[45] The geographical distribution of hospitals in the DRC is often characterised by a concentration in urban centres (Chenge et al., 2010).

F IV: sleeping sickness

We collect data on the geographic distribution of the sleeping sickness from the public health reports of the Ministry of Colonies (maps in 1910, 1928, and 1933 to 1938). The maps were produced as a result of surveys of sleeping sickness conducted across regions of the Congo by the colonial medical services in the corresponding years. After digitising the maps, we constructed the sleeping instrument as the geographic area where the reported prevalence of the disease is at least equal to 1% (i.e. a threshold set by the colonial authorities).

Figure A18: Map of sleeping sickness in 1933



Notes: The figure shows the geographic distribution of the sleeping sickness in Belgian Congo in December 1933. Source: Bureau of Hygiene and Tropic Disease.

F.1 Testing LATE assumptions

We follow the test procedure developed by Farbmacher et al. (2022) that employs random forests and classification and regression trees to find violations of exclusion assumption. The test first consists of splitting the data sample along the covariate space using pruned regression trees to find relevant subgroups where potential violations are more likely to be found. The full data sample is partitioned with the classification and regression trees (CART) algorithm along the observable covariates in a way that maximises effect heterogeneity across the newly formed partitions. Causal forests are then used to estimate the magnitude of the potential violations in these subgroups by combining results from a large number of trees built on random subsamples of the data. Positive values of the causal forest estimates

Table A20: Entropy balancing for geographic characteristics

	Before entropy balancing (raw data)			After entropy
	Colonial	Post-Independence	Standardised difference	Balanced sample
	(1)	(2)	(3)	(4)
Distance Provincial city	6.773	6.960	0.448	6.773
Distance coast	5.349	4.352	-0.578	5.349
Distance transport mode	2.661	2.718	0.038	2.661
Mineral resources	0.351	0.582	0.469	0.351
Population density 1921	4.014	4.757	0.241	4.014
Elevation	602.200	857.410	0.470	602.200

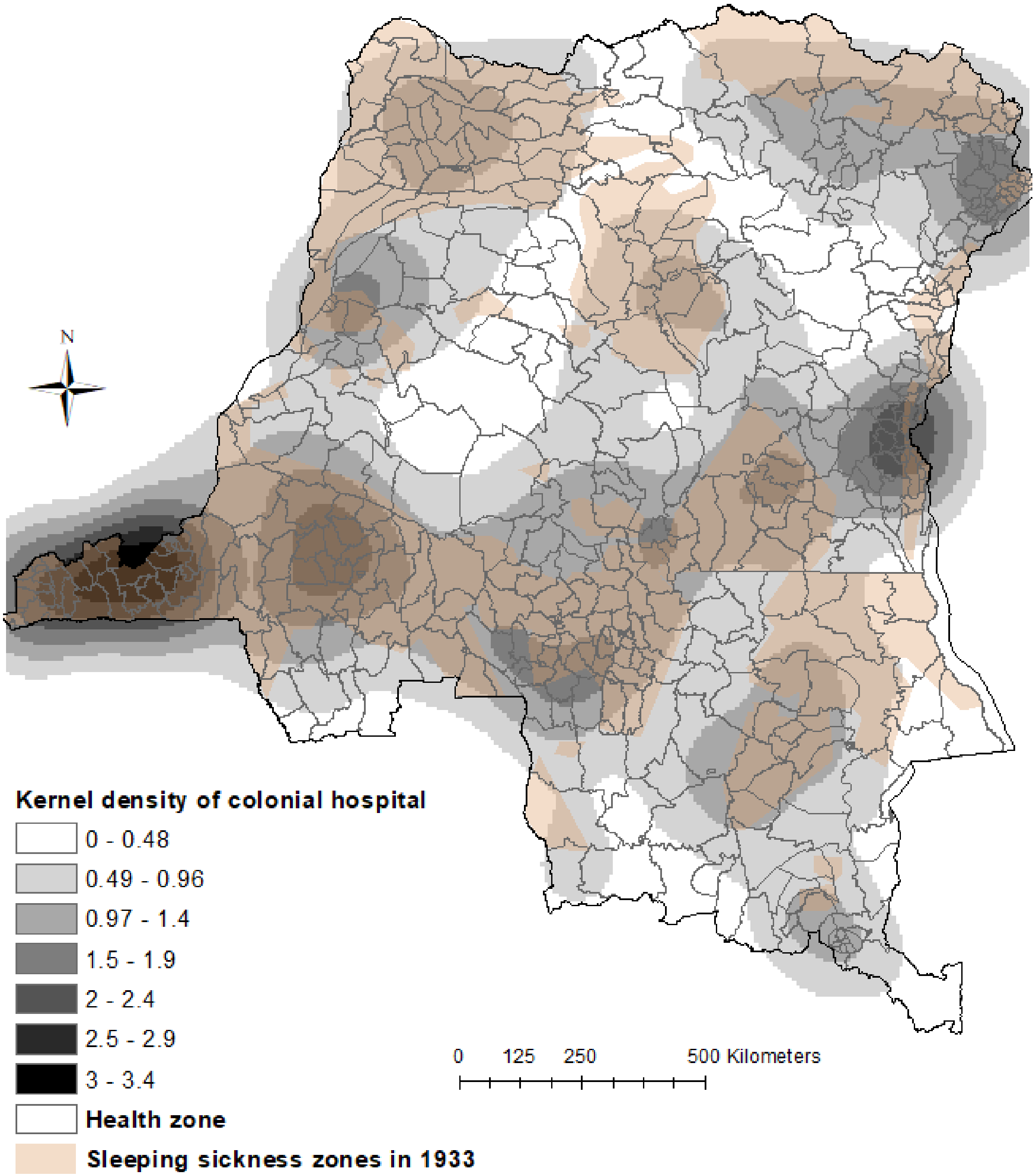
Notes: .

Table A21: Colonial settlement and hospital outcomes: IV and Entropy balancing

	Hospital	Government	Health services: admissions			
Dep. Variable	capacity	transfers	Total	Malaria	Diarrhea	Emergency
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. 1st stage						
Sleeping sickness	0.402***	0.418***	0.400***	0.404***	0.401***	0.435***
	(0.033)	(0.037)	(0.031)	(0.031)	(0.031)	(0.034)
Kleibergen-Paap F-statistic	153.1	130.5	162.8	169.2	163.4	166.7
Panel B. Reduced form						
Sleeping sickness	0.168***	0.236***	0.019	0.037	0.000	0.086
	(0.041)	(0.081)	(0.051)	(0.064)	(0.057)	(0.079)
Standardised β coefficient	0.114	0.086	0.011	0.019	0.000	0.039
R^2	0.64	0.59	0.53	0.45	0.36	0.41
Observations	981	755	1,040	1,050	1,051	915
Panel C. 2nd stage						
Colonial settlement	0.418***	0.565***	0.046	0.092	0.001	0.198
	(0.102)	(0.194)	(0.127)	(0.158)	(0.142)	(0.182)
Standardised β coefficient	0.275	0.201	0.027	0.045	0.000	0.088
Anderson-Rubin p-value	0.00	0.00	0.71	0.55	1.00	0.26
R^2	0.56	0.55	0.44	0.35	0.17	0.27
Observations	981	755	1,040	1,050	1,051	915

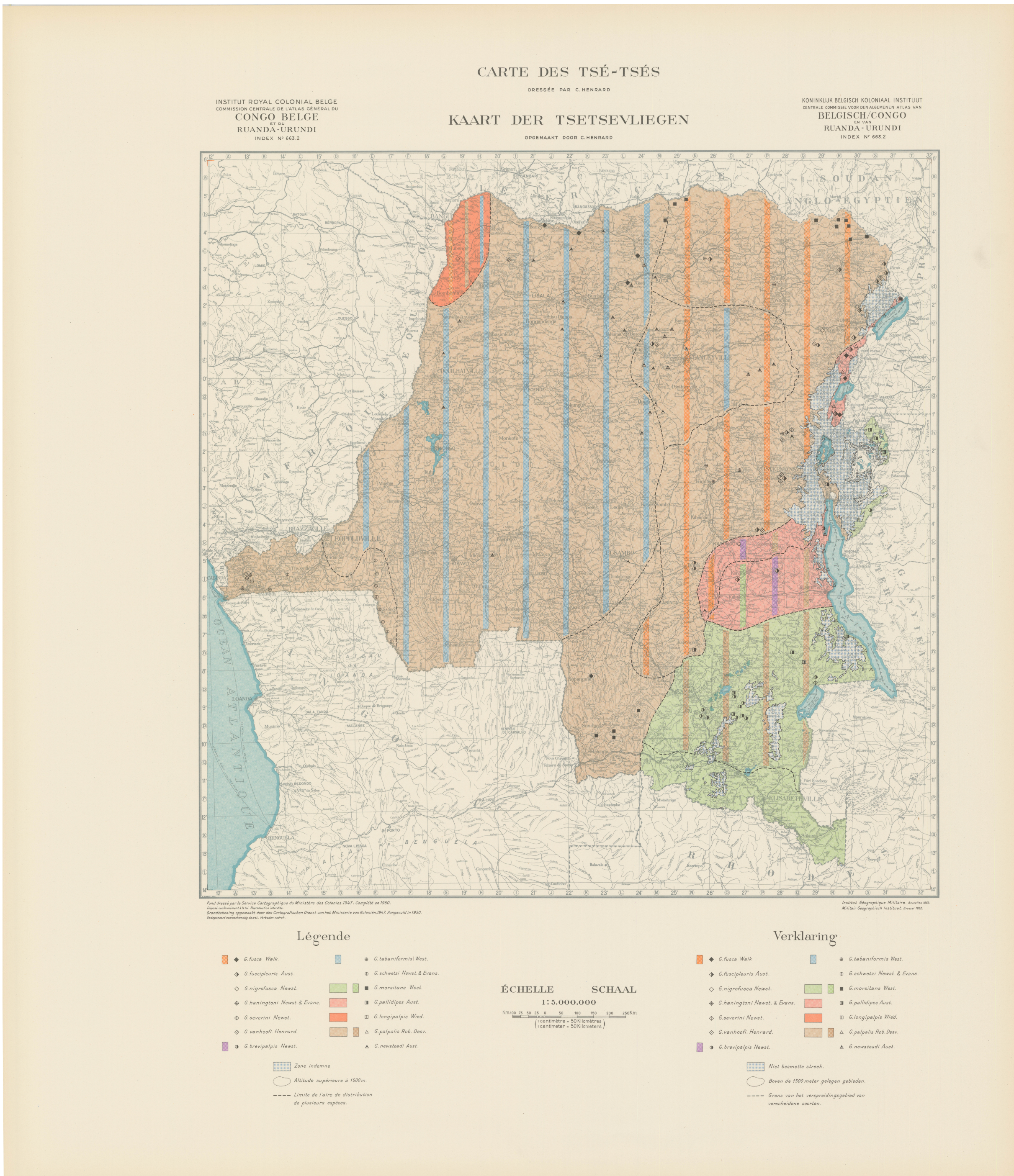
Notes: The table presents the 2SLS estimates of equation (1) after using entropy weights from the balancing algorithm Hainmueller (2012) that imposes the control group (areas without sleeping sickness) to have the same mean and the same variance as the treatment group (areas with sleeping sickness) for all geographic variables. The sleeping sickness instrument is a dummy variable equal to one if the hospital is located within an area where the infection rate was least equal to 1% at any time during the 1929-1953 period. Baseline controls are those presented in panel B of Table 2. Robust standard errors are in parentheses. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Figure A19: Kernel density of colonial settlements and the presence of sleeping sickness in 1933



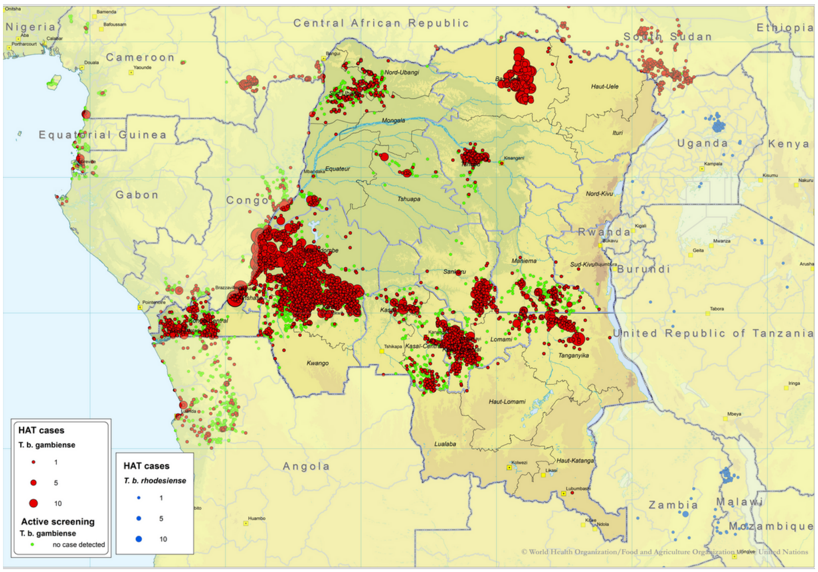
Notes: The map depicts the kernel density of colonial health settlements and the geographic distribution of the sleeping sickness (in brown) by health zones (district level) as reported in the public health data of the Ministry of Colonies between 1928 and 1933 (Lyons, 2002). A health zone is reported with sleeping sickness when the prevalence of the disease is at least equal to 1%.

Figure A20: Geographic distribution of the tsetse fly in 1950

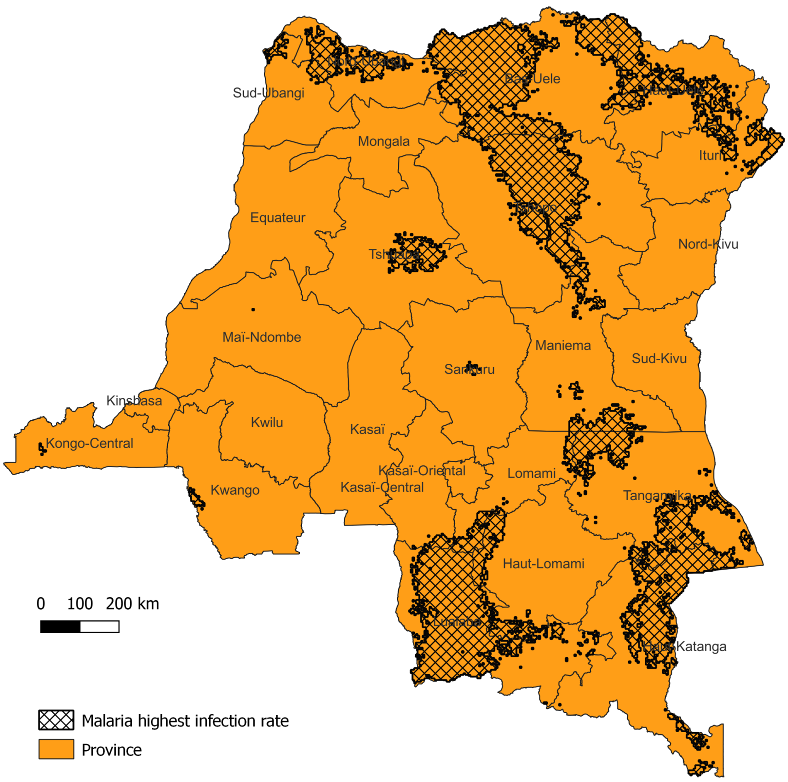


Notes: The figure shows the geographic distribution of the tsetse fly in 1950. Source: Service Cartographique du Ministere des Colonies.

indicate local violations. Finally, the null hypothesis of no local violation of the exclusion assumption is tested using Bonferroni-corrected critical values for multiple hypothesis testing. Any violation in at least one subpopulation would challenge the validity of the instrument.



(A) Distribution of sleeping sickness (2012-2016)



(B) Distribution of PfPR rate (2017)

Notes: The map in Panel A depicts the geographical distribution of sleeping sickness (Human African Trypanosomiasis) through the reported number of new cases between 2012 and 2016. Panel B shows the geographic distribution of the highest (above median) Plasmodium falciparum parasite rate (PfPR) using median values for 2017 from the Malaria Atlas Project (MAP). *Source:* Panel A is produced by **franco2017** and accessed from the WHO website (`https://www.who.int/trypanosomiasis_african/country/foci_AFRO/en/`). Panel B obtained from author's computation using the MAP data on PfPR in the DRC in 2017.

Table A22: Test results of the validity of Sleeping sickness

Dep. Variable	Bed capacity	Government transfers	Total admissions	Malaria	Diarrhea	Emergency
	(1)	(2)	(3)	(4)	(5)	(6)
t-stat	0.920	0.000	0.000	0.939	0.080	-2.287
critical value $c(\alpha)$	2.241	1.960	2.394	2.128	2.241	1.959
p-value	0.715	0.999	0.999	0.522	0.999	0.999

Notes: The table presents the results of the procedure developed by Farbmacher et al. (2022) that employs causal forests to detect and test local violations of the exclusion restriction. The instrument tested is sleeping sickness. The set of covariates includes all baseline and geographic controls presented in Table **??**. Rejecting the null hypothesis indicates that the exclusion assumption is violated at least in one subpopulation. The software package `LATEtest` in R was used to implement the tests.

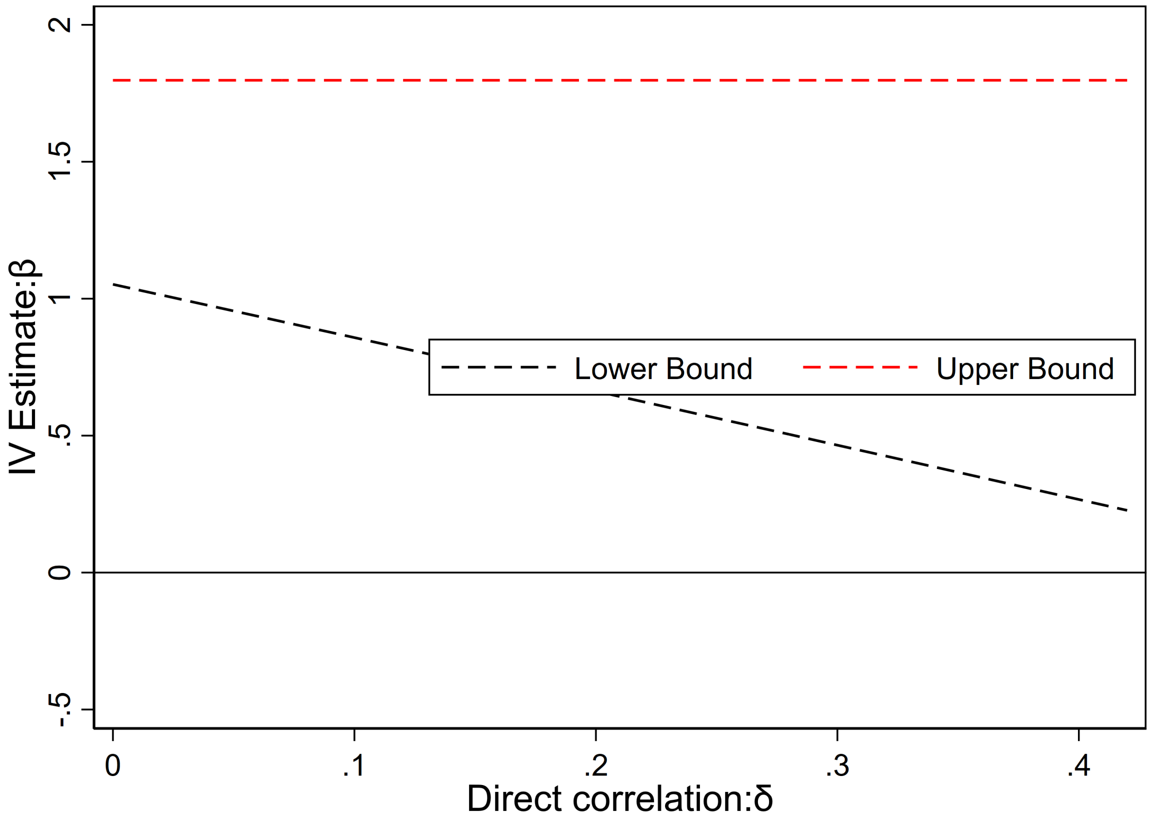
F.2 Relaxing instrument exogeneity

In this section, we relax the strict exogeneity assumption by following the plausibly exogenous methodology in Conley et al. (2012) that allows for a direct effect of sleeping sickness on government transfer. Consider the following structural equation:

$$\mathbf{Y}_{ij} = \beta Colonial_{ij} + \delta Sleeping_{ij} + \epsilon_{ij}$$

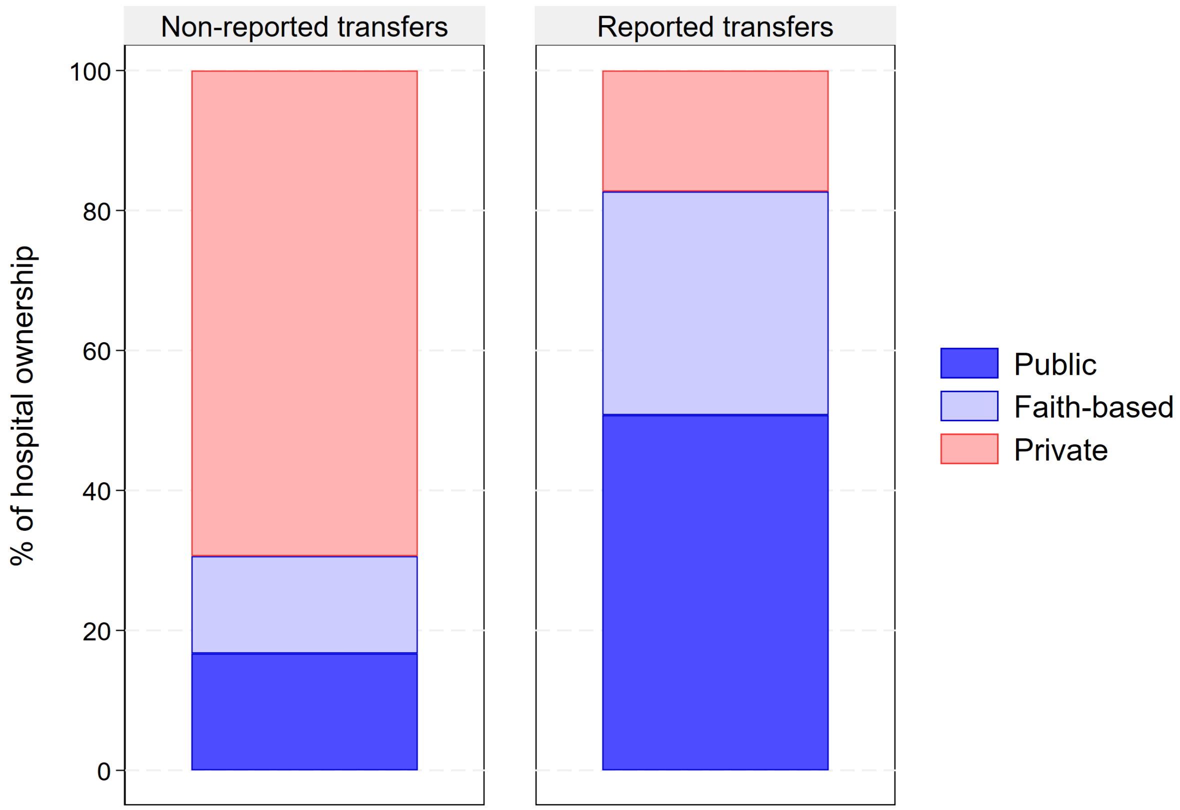
with $Colonial_{ij}$ the endogenous variable, and $Sleeping_{ij}$ the instrumental variable. Under strict exogeneity assumption, the instrument $Sleeping_{ij}$ has no direct effect on the outcome $\mathbf{Y}_{ij}$ and δ is equal to zero. Conley et al. (2012)'s methodology departs from this latter assumption by allowing to flexibly specify a range of non-zero values that δ can take, in the above structural equation. Conley et al. (2012) show that their approach is particularly well suited to empirical applications with strong instruments, which is the case with the sleeping sickness instrument. To gauge magnitudes, the overall reduced-form estimate of the sleeping sickness instrument on government transfers has a 95% confidence interval between 0.411 and 0.610. Assuming that the effects of our instrument on $\mathbf{Y}_{ij}$ should be smaller than the effect of $Colonial_{ij}$ on $\mathbf{Y}_{ij}$, this evidence suggests that a direct correlation between sleeping sickness and government transfers could be found in the interval 0 and 0.420. Figure A22 plots all estimated 95% confidence intervals for β that vary with $\delta \in [0, 0.420]$ using the "Union of Confidence Interval" approach. By varying δ over a range of plausible values, the estimated confidence intervals of the second-stage coefficient on colonial settlement remain positive.

Figure A22: Confidence intervals of IV Estimates under plausible exogeneity



Notes: The graph plots the upper and lower bounds of the 95% confidence intervals of the IV estimate on government transfer using Conley et al. (2012)'s methodology on Union of Confidence Intervals approach. The algorithm was implemented by Clarke and Matta (2018).

Figure A23: Share of hospital ownership and unreporting of government transfers



Notes: The graph plots the share of hospital ownership among hospitals with and without reporting of government transfers.

G Additional channels

We explore in this section additional channels that could drive our results.

Economic development. We first explore whether the colonial effect could operate through higher levels of local economic development across the country, using nightlight luminosity data. Early colonial exposure could have favoured state-making and higher public investments with positive long term effects on contemporary development. The cfolonial effect on government ransfers would then be mediated by the government's promotion of areas with higher economic development through greater provision of public goods (Besley and Persson, 2011). Columns (1-2) of Table 9 reports the effect with and without province fixed effect and documents a negative relationship with economic outcome.

Malaria risk. The enormous modern health burden of malaria could find its origin in colonial development. Although we control for the risk of malaria burden in our baseline results, the statistically significant effect of colonial origin found with OLS estimation on patients treated with malaria suggests that the disease may have an important role. However, Columns (3-4) of Table 9 do not show any statistically significant of colonial settlement on malaria risk.

Ethnic favouritism. Colonial activities could have favoured the establishment of an educated and politically oriented group that evolved into a powerful, corrupted elite after independence. This political elite could subsequently have favoured their home regions/towns for the allocation of public (including health) resources (Burgess et al., 2015). To test the relevance of ethnic representation at the national level, we retrieve information on politically relevant ethnic groups from the Ethnic Power Relations (EPR) dataset (Vogt et al., 2015), where a group is defined as politically relevant if at least one political organization claims to represent it in national politics or its members are subjected to state-led political discrimination. We construct an indicator variable equal to one if the geographical ethnic area to which a hospital belongs is politically relevant during the 2017-2021 period, or if it was historically relevant during the 1965-1997 Mobutu era, and zero otherwise.[46] Because of the small number of persons who ruled the country in the postcolonial period, we are likely to identify the presence of ethnic favouritism with the central government if it exists in the government transfers to hospitals.[47] Our results in Columns (5-6) rule out this possibility.

Congo Free State and mining concessions. We next consider mining concessions which may have indirect persistent effects. During the Congo Free State (before 1908), the state partitioned the territory into economic and social areas, to ensure the preponderance of Belgian capital through granted concessions to private enterprises. Although the largest companies were dissolved after 1908, the inter-

[46] A concern about the validity of this coding could be that ethnic identity of the government forces and the executive power may differ in some settings (Harkness, 2022). Using information from the Ethnic Stacking in Africa Dataset (ESAD) confirms that this concern does not apply to the DRC, where the ethnicity of both political leaders and the military has historically been aligned.

[47] Joseph Mobutu ruled the Congo from 1965 to 1997. Laurent Kabila took power after to become the President of the DRC until his assassination in 2001. He was succeeded by his son, Joseph Kabila, who remained President until 2019. A member of the Ngbandi ethnic group, Mobutu was born in the Mongala province but grew up in the village of Gbadolie, in the province of Nord-Ubangi, where he later established his infamous presidential palace; Laurent Kabila was from the Tanganyika province with both Luba and Lunda ethnic origins; Joseph Kabila is from the South Kivu province.

dependence between the state and private enterprises continued to affect the development of institutions and political control during the latter period of the colonisation of the Belgian Congo (Vellut, 1981). It is then possible that colonial health investments where higher in these areas. Historical exposure to the concessions also has negative long-run effect on local development and health outcomes (Lowes and Montero, 2021), which could motivate differential allocations of public resources. We do not find supportive evidence for this channel in Columns (7-8).

Institutional quality. Another possibility is that colonial settlements contributed to establish relatively higher performing local institutions. To circumvent the lack of information on local governance quality, we investigate whether colonial settlements is associated with current level of corruption. Whilst misuse of public funds could prevent health facilities from reaching their full share of government funding, the local institutions established by colonial settlements may participate in deterring the embezzlement of public funds (for example, dedicated departments of inspection of local resources, or transparency indicators). To explore this assumption, we collect data on motion of no confidence initiated against initiated against a provincial governor as a proxy for embezzlement of public funds. We construct a dummy variable equal to one if the province governor was prosecuted for corruption interacted with the distance to the capital of the province to capture the influence of potential elite capture of government transfer. We do not find any statistically significant effect.

Table A23: Hospital equipments

	Glucometer	Microscope	Spectrophotometer	Anesthesia	Equipment utilisation	Prob(Equipment)
	(1)	(2)	(3)	(4)	(5)	(6)
Colonial settlement	-0.685	-1.592	-0.550	1.507**	-0.015	0.004
	(1.090)	(1.445)	(0.682)	(0.688)	(0.105)	(0.030)
Standardised β coefficient	-0.026	-0.055	-0.036	0.070	-0.006	0.003
R^2	0.28	0.18	0.16	0.39	0.26	0.18
Observations	732	613	865	858	876	1,064
Mean dep. var	21.71	15.33	28.34	13.88	0.15	0.48
Province Fixed Effects	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓

Notes: The unit of analysis is hospital. The table presents the OLS estimates of equation (1) with four hospital equipments as dependent variables: Glucometer, Microscope, Spectrophotometer, Ketamine for medically-delegated analgesia. Column (5) defines equipment utilisation by extracting the first principal component of Columns (1-4). Column (6) corresponds to the probability of having all the four equipments. All regressions add to the baseline controls the total number of hospital admissions. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A24: Additional hospital outcomes

	Value of ward stock	Investment	Expenditure		Revenue		Length of stay	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Colonial settlement	0.126	0.174	0.356***	0.248*	0.308**	0.215*	0.190***	0.041
	(0.133)	(0.167)	(0.104)	(0.123)	(0.127)	(0.124)	(0.058)	(0.064)
Standardised β coefficient	0.035	0.031	0.093	0.065	0.068	0.049	0.075	0.016
R^2	0.45	0.23	0.49	0.51	0.50	0.48	0.62	0.69
Observations	742	846	800	776	842	814	939	937
Mean dep. var	12.81	14.30	14.56	14.59	14.71	14.80	6.21	6.21
Province Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓	✓	✓
Total outpatients	✓	✓	✓	✓	✓	✓	✓	✓
No. Beds				✓		✓		✓

Notes: The unit of analysis is hospital. The table presents the OLS estimates of equation (1) with additional hospital characteristics as dependent variables. Value of ward stock corresponds to the value of the medicine in the stock. Expenditure includes social charges, purchase of furniture and medicines. Length of stay corresponds to the total number of days that patients spend in hospital. All outcomes are taken in logarithm. All regressions add to the baseline controls the total number of hospital admissions, and Column (6) account for the number of beds instead of the number of health workers. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A25: Colonial settlement and hospital outcomes: Referral hospitals

Dep. Variable	Bed capacity (1)	Government transfers (2)	Health services: admissions Total (3)	Malaria (4)	Diarrhea (5)	Emergency (6)
Panel A. OLS						
Colonial settlement	0.218***	0.203**	-0.013	0.136*	-0.037	-0.022
	(0.043)	(0.093)	(0.050)	(0.070)	(0.064)	(0.090)
Standardised β coefficient	0.188	0.094	-0.010	0.081	-0.025	-0.011
R^2	0.54	0.50	0.48	0.36	0.32	0.35
Observations	477	422	473	477	477	471
Panel B. Matching estimation						
Nearest-neighbor(1)						
Colonial settlement	0.292***	0.321***	0.099	0.029	-0.067	-0.057
	(0.054)	(0.097)	(0.065)	(0.083)	(0.081)	(0.121)
Nearest-neighbor(3)						
Colonial settlement	0.290***	0.403***	0.133**	0.036	-0.072	-0.086
	(0.048)	(0.089)	(0.057)	(0.074)	(0.077)	(0.105)
Exact matching: HW quintiles						
Colonial settlement	0.200***	0.368***	0.014	0.048	-0.080	-0.114
	(0.045)	(0.108)	(0.055)	(0.087)	(0.085)	(0.115)
Entropy reweighting						
Colonial settlement	0.284***	0.387**	-0.028	0.113	0.006	-0.041
	(0.083)	(0.183)	(0.081)	(0.122)	(0.114)	(0.150)
Matching variables as in Panel A	✓	✓	✓	✓	✓	✓
Observations	477	422	473	477	477	471
Panel C. 2SLS estimation						
Colonial settlement	0.303***	0.240*	0.025	0.140	-0.148	-0.053
	(0.074)	(0.141)	(0.092)	(0.123)	(0.122)	(0.158)
Standardised β coefficient	0.260	0.111	0.019	0.083	-0.099	-0.025
Anderson-Rubin p-value	0.00	0.08	0.77	0.24	0.20	0.73
R^2	0.43	0.42	0.39	0.25	0.10	0.20
Observations	477	422	473	477	477	471
Baseline controls	✓	✓	✓	✓	✓	✓
Province Fixed Effect	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓

Notes: The Table replicates the baseline results restricting on general referral hospitals. Panel A presents the OLS estimates of equation (1). The unit of observation is a hospital. Nondummy variables are all in natural logarithms. Geographic controls include distance to provincial capital, distance to pharmaceutical distribution centres, distance to nearest transport, population density in 1951, malaria risk rate, elevation, longitude and latitude, and distance to conflict events, and a dummy variable equal to one for the exploitation of natural resources during the colonial period. Robust standard errors in parentheses are clustered at the provincial level. Panel B presents the estimates from different matching estimations, using the controls listed in panel A as matching variables, except for province fixed effects. The first three matching methods present average treatment effects on the treated, based on propensity score matching, using respectively one nearest-neighbour, three nearest-neighbours, and exact matching on health workers (HW) quintiles in addition to using the matching variables in panel A. The last mating approach presents estimates using the entropy balancing algorithm (Hainmueller, 2012) which reweights the post-independence hospitals to match the mean and the variance of the covariates of colonial hospitals. Panel C. presents the 2SLS estimates with the sleeping sickness instrument introduced in Section 5. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

Table A26: Government transfers, health workers and bed capacity

	Government transfers			
	(1)	(2)	(3)	(4)
Health workers	0.563***		0.349***	0.337***
	(0.055)		(0.077)	(0.075)
Physicians	0.719***		0.652***	0.632***
	(0.088)		(0.071)	(0.071)
Bed capacity		1.099***	0.414***	0.363***
		(0.086)	(0.087)	(0.085)
Colonial settlement				0.264***
				(0.080)
Standardised β coefficient	0.012	-0.099	-0.001	0.086
R^2	0.52	0.42	0.56	0.56
Observations	731	731	731	731
Mean dep. var	14.30	14.30	14.30	14.30
Province Fixed Effects	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓

Notes: The table presents the OLS estimates of equation (1) with only government transfers as the dependent variable. The unit of observation is a hospital. Health workers is defined by all categories of nurses, and physicians include generalists and specialists. Bed capacity is the total number of beds. Nondummy variables are in logarithm transformation. All columns include the baseline controls except for the number of physicians. Robust standard errors in parentheses are clustered at the provincial level. *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively.

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