The Effects of Direct and Indirect Colonial Rule on Health Outcomes in India

Graduate Thesis

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The objective of this project is to detect the presence of disparities in health outcomes explained by direct and indirect colonial rule in 20th Century India. I use the Household Members dataset from National Family Health Survey (NFHS) 2015-16 along with a set of average geospatial covariates. The main outcomes of interest include biomarker variables collapsed at the district level in an Instrumental Variables regression to examine causal effects. I find that regions under direct British Rule have improved health indicators on average. Moreover, I find that these indicators only improve for the upper quantiles of the working population with already worse-off health. I also find that households who identify as a Scheduled Tribe do not benefit as much as the general population. Moreover, direct British Rule cannot explain a range of crucial health indicators for Tribal populations today. This points out the presence of historical inequities to access healthcare that still persists in the postcolonial period.

I. Introduction

India's record in the global burden of disease is still behind various emerging economies, ranked 125th globally in life expectancy and 97th for undernutrition (Grebmer et al. (2016); WHO (2016)). Obesity and low dietary intake are two of the leading causes of death (IHME (2019)). South Asia ranks one of the highest in anemia prevalence (Stevens et al. (2013)). Moreover, there are large regional variations in health indicators. For example, South India performs well in health performance than various populous regions in the North, where general health is worse than in many sub-Saharan countries. There also exists socioeconomic disparities in health indicators. Under-five mortality rates are high with low immunisation rates across Scheduled Tribes compared to the high-income quintiles.

In this paper, I examine whether modern-day health variations in India can be explained by its colonial history. I test the persistence of varying degrees of colonial rule in India using its peculiar division into direct and indirect British Rule in the 19th century. To expound on the two types of administration in colonial India, indirect rule was a special status of autonomous internal administration given to regional kings, with foreign policy and defense controlled by the British Crown. These regions were later amalgamated into a uniform government after independence in 1947. Since there is a problem of self-selection, I use Iyer's (2010) exogenous identification to assign Indian regions to British Rule. The exogenous variation comes from Lord Dalhousie's Doctrine of Lapse, where between 1848-1856, the East India Company annexed regional kingdoms if the ruler died without a natural heir. I use this policy as an instrument to assign regions to direct British Rule. The identifying assumption is that the death of a ruler without a biological heir is a matter of circumstance and is unlikely to directly impact health outcomes in postcolonial India.

This work enriches existing literature in three ways. First, it expands Iyer's exogenous identification to a new set of Indian districts (as of 2011) and tests the presence of healthcare inequities in the 21st century ex-

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plained by the colonial administration. Second, I provide strong evidence of heterogeneous effects across the NFHS sample by examining health indicators restricted to Scheduled Tribe households. I find that Tribal households have not benefited as much as the general population. The instrumental variable often does not seem to significantly explain effects in a range of biomarkers. Finally, I also attempt to explore potential heterogeneities in health effects across the age distribution of the NFHS data using Quantile IV regressions.

I find that regions under direct British Rule under the instrumental variables approach have significantly better health outcomes on average. This contrasts with the upwards bias of OLS estimates, signaling a high degree of selectivity in annexation by the East India Company. I report a strong first-stage F-statistic to show that the instrument is strong and robust to adding a range of household, health, and geographical controls. Moreover, reduced-form regressions further strongly suggest that the instrument does not directly affect health outcomes. I also provide historical evidence that shows the exogenous nature of the policy.

I outline some historical mechanisms that can potentially explain the health disparities found in this paper. First, I provide historical evidence to detail how access to health policy in British India was primarily established for British personnel. Therefore, I argue that access to healthcare was staggered among Indians. I test this mechanism by restricting my data to Scheduled Tribes and find if the effect of being under British Rule is significantly less than the full sample. Second, I argue that a late recognition of decentralised legislation in health policy from the colonial era has led to crucial problems in today's regulatory bodies, which results in inequities in healthcare. Since I am unable to directly test this transmission channel, I summarise recent literature that highlights this mechanism.

The rest of the paper is organized as follows. Section II presents related literature on the historical determinants of health outcomes. Section III outlines direct and indirect rule in British India. Section IV details health policy in British India along with my hypotheses and potential mechanisms. Section V presents potential mechanisms and hypotheses. Section VI compares OLS and IV estimates for the full sample and then with restricted samples, along with a brief on Quantile IV Regression Estimates. Section VII extends Section V to potentially explain my results and propose further research. Section VIII concludes.

II. Related Literature

This work builds on a wide set of literature on decolonialism and its policy implications for postcolonial development. Decolonial literature widely accepts the stickiness of colonial institutions decades after independence and their effects on present-day economic outcomes. The mechanisms that affect current outcomes vary across the board - dependency complexes, over-exploitation, and drain of resources (Frank (1978); Bagchi (1982)). Of special focus is Acemoglu, Johnson and Robinson (2001) that relates patterns of European settlements to the current quality of institutions. They conclude that colonies with lower rates of European settlers create "extractive economies" (e.g. India) which reflect current institutions with low quality of property contracts.

Standard literature on Indian colonial history overwhelmingly examines macroeconomic outcomes. These range from wealth inequalities (Angeles (2007)), institutional growth, land tenure systems (Banerjee and Iyer (2005)), and public good provision (Banerjee and Somanathan (2007) and references therein). Inequities to healthcare access in India broadly cover present-day issues in policy making and the mechanisms of discrimination based on caste, religion, and gender (Baru et al. (2010), Subramanian et al. (2008)).

To the best of my knowledge, the historicity of healthcare disparities is generally descriptive except for a sparse collection of recent literature. Previous papers have explored the history of religiosity vis-a-vis

health outcomes. Bhalotra, Valente and van Soest (2010) and Brainerd and Menon (2015) discuss infant mortality explained by religion. Menon and McQueeny (2015) use Christian missions as an instrument to find higher survival rates of Christian infants compared to other religious identities.

In a similar vein of research, Calvi and Mantovanelli (2018) use religion to explain anthropometric indicators, where they measure the long-term consequences of Protestant medical missions that spread throughout India in the nineteenth century. Their analysis finds a positive association between proximity to a Protestant medical mission and the current health outcomes of households. They also report that this association is unrelated to religious conversion but related to improvements in health potentials and hygiene habits.

Iyer (2010) uses an IV strategy to divide current Indian districts into direct and indirect rule and concludes that regions directly administered by the British experience lower levels of public good provision in the post-colonial period. Her strategy employed the Doctrine of Lapse, a policy applied till 1858 in India. The policy allowed the British East India Company to annex native states if and when the ruler displayed incompetence or died without an heir. This policy allowed her to solve the issue of self-selection and employ an instrumental variable method. A crucial contribution of this project is to test the presence of health outcomes using the latest 2015-16 National Family Health Survey (NFHS) using the identification strategy aforementioned. While Iyer duly tested disparities in infant mortality and literacy, the analysis falls short of a holistic analysis of health measures within regions of direct and indirect rule. Moreover, Iyer's work involved amalgamating modern districts of India into erstwhile Native States and British Rule. This paper preserves the boundaries of modern Indian districts surveyed by the NFHS and assigns them into (in)direct rule, thus obtaining a closer look into health disparities.

The current literature highlighted above looks at the effect of various historical variables on health indicators using standard OLS/IV estimators. The conditional mean and constant effect assumptions hide crucial heterogeneities in treatment effects. For example, the effect of policies on Body Mass Index shall be different across its distribution among the age groups considered. Hence, if the effect of a policy is positive, assuming a constant effect like in OLS confuses a falling BMI for an already obese observation with an underweight sample of respondents. I attempt to move beyond the current literature by looking at effects using quantile regression methods. This way, I can attempt to correctly measure the effects of health indicators across the age distribution.

III. Direct and Indirect British Rule in India

The presence of the British Empire stretches nearly 200 years beginning from 1757 with the East India Company's control of the Bengal region. The advancement of the Company's rule (hereafter *Company Raj*) extended from revenue collection rights to direct administration. Company Raj dissolved after the Indian Rebellion of 1857 and the administration of the region which included Pakistan, Bangladesh, and Burma (present-day Myanmar) passed on to the British Crown (hereafter *British Raj*). The entirety of the Indian subcontinent was not annexed due to subsequent changes in annexation policy. After the 1857 Rebellion, the annexation of regional kingdoms stopped and changed with three major policies - the *Ring Fence* (1765-1818), *Subordinate Isolation* (1818-1858), and the *Right of Intervention* (1858-1947).

To that end, the precise definition of regional kingdoms has changed over time within the colonial period. More generally, these kingdoms (hereafter *Native States*) were under autonomous internal administration by Indian kings whereas defense and foreign policy were controlled by the British Raj [1]. After a wave

[1] Definitions of 1910 British reports and the Imperial Gazetteer can be used to interpret a Native State as those regions that had been recognised

of annexations subsiding after 1858, Native States varied from small regions and towns, with Hyderabad (Deccan Peninsula), Mysore (South West), and Rajputana (Northwest) being the largest states. The three annexation policies aforementioned are summarized below -

1. *The Ring Fence*: Before the British Crown took over the administration of the Indian subcontinent, the East India Company's resources to annex and rule were still in the nascent stages. Therefore, the period from 1765 to 1818 witnessed a "ring-fence" between Company ruled regions and major kingdoms as a way of imposing strategic barriers. Implemented by Warren Hastings, the policy more generally implied the provision for subsidiary forces, commanded by the Company and paid for by the rulers of the Native States. Native territories were also ceded or granted to the Company in lieu of debt default or tribute.

2. *Subordinate Isolation*: After winning the Third Anglo-Maratha War (1817-18), the Company was able to administer large regions of land, especially in the Deccan Peninsula. Now, the Native States were made subordinate to the Company and were strategically persuaded to recognise British paramountcy. The Native States were unable to declare war and engage in diplomatic relations with other States. Moreover, between 1818 and 1848, annexation was more rapid under Governor-General Lord Dalhousie. Apart from the Second Anglo-Sikh War in Punjab (1848-49), Lord Dalhousie employed debt default and misrule to annex regions, including the notorious Doctrine of Lapse, where he refused to recognise adopted heirs and control States where the ruler died without a biological heir.

3. *Post-1857 Policy*: The Sepoy Mutiny of 1857 forced the British Government to seriously reconsider the administration of the Indian subcontinent. The British Crown took over from the East India Company. Since various Native States had aided the British in the rebellion, annexation took a back seat. The British gave up outright control of Native States, but they reserved the right to intervene [2], including deposing a ruler and assigning an intermittent regency.

Indirect rule in the subcontinent was marked by a small set of large Native States that consistently registered non-conformity with the British Raj. The remaining Native States were large in number but small and scattered all across the region. The British Crown after the 1857 rebellion proposed the policy of admitting British "residents" in the courts of the Native States that primarily oversaw the functioning of the native ruler's autonomous administration and at times settle succession disputes. The duties of the resident were particularly strong in the small Native States but their position would subsequently wane in the larger Native States.

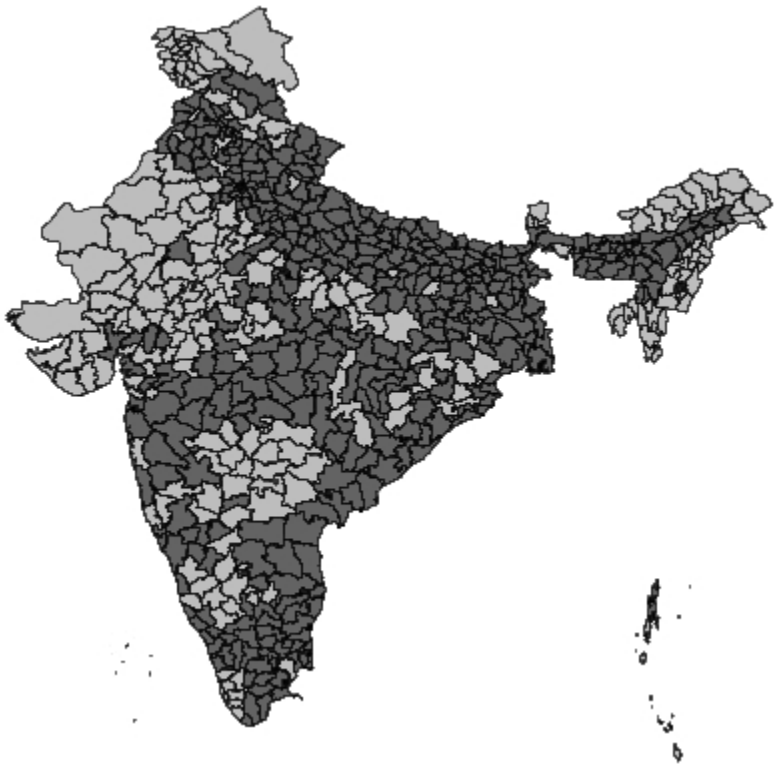
After gaining Independence from British Raj in 1947, the patchwork of Native States all across the subcontinent acceded to the new Union Government by 1950. Most of the ascension procedures were executed voluntarily, with the exception of Hyderabad, where a military threat was imposed. The newly acceded Native States were subject to the same legal, administrative, and political institutions as the erstwhile British Indian territory. Moreover, the nobility of the acceded States continued to enjoy a stable presence in independent India's central/federal administration apart from receiving privy purses, which was later discontinued in 1971.

While Iyer (2010) has mapped present-day Indian districts into direct and indirect rule, the full assignment of colonial rule is incomplete. Foremost, her data arguably observe a subset of the universe of districts. Also, the district names and boundaries have considerably changed from the late 20th century to the more recent 2011 reorganization, which divides the country into 640 districts. I assign the new 2011 districts

by the British Raj as such. The precise quote from Sir William Lee Warner puts the definition in perspective, "a political community subject to a common and responsible ruler...duly recognised by the British Government, undertaking any of the functions and attributes of internal sovereignty."

[2] Lord Canning, Government of India Foreign Department Dispatch No. 43A, April 30, 1860

Figure 1. : British Raj (Dark Grey) as of 1947



into direct and indirect rule, expanding and improving my analysis on a new set of district boundaries.

Figure 11 shows the extent of British Raj in dark grey. The British Foreign Office in 1910 recognised upto 45% of British India as Native States (excluding Burma and Sindh). These States were distributed all across the region, with larger concentrations in the Northwest and the Deccan Peninsula.

IV. A Brief History of Health Policy in India

This section provides a summary of the institutional capacities of British India for public health, including Native States and British presidencies. Overall, the British model of health management primarily favoured the colonial settlers. Any spillover of health policy toward the general population was very late and slow. In contrast, Native States initially lacked access to Western medicine, relying more on traditional medicine. Formal health institutions as a whole were developed quite late in these regions compared to British regions. I provide a detailed outline of the differences in public health delivery between colonial and present-day India in Section VII while I discuss my results.

Public Health Management in erstwhile British Territories

The treatment and management of infectious diseases and general health trace back to the epidemiology of tropical diseases and medicine (Mushtaq (2009)). Proto-institutions surrounding medicine and health were established as early as the advent of the East India Company in the 1700s. One must note, however, that health policy was consistent in serving the Company's Army and administration. Medical departments were established in Bengal in 1764 for rendering medical services to the troops and servants of the Company. In 1775, Hospital Boards were formed to administer European hospitals comprising the Surgeon General and Physician General, who comprised the staff of the Commander-in-Chief of the Royal Indian

Army.

The departments aforementioned were subsequently amalgamated into medical boards involving military and civil service. The end of Company Raj marked a subsequent formalisation of civil services. However, it was not until 1869 that a Public Health Commissioner and a Statistician were appointed by the British Raj. The medical boards and the civil service established until the late 1800s were highly centralised. The Montgomery-Chelmsford Constitutional Reforms of 1919 was a first step in decentralising the civil service to British provinces. The 1919 reforms were insufficient to the Indian National Congress and various grassroots nationalists, sparking a turbulent period of resistance and oppression of dissent. The Government of India Act of 1935 further decentralised legislation with separate provisions for federal, federal-cum-provincial, and provincial jurisdictions. A Central Advisory Board of Health was attached with the Public Health Commissioner in 1937. The Bhore Committee established the Health Survey and Development Committee in 1946 to survey health indicators for the subcontinent.

With regards to medical institutions, the first hospital in India was the Madras General Hospital, established in 1679. The Presidency General Hospital in Calcutta (present-day Kolkata), Bengal was established in 1796 under Company Rule. Medical education and training, however, was a very slow process. The earliest such institution was the Calcutta Medical College (1835), the first Western medicine institute in Asia. Eventually, a nascent network of hospitals and minor dispensaries developed. The government of India agreed to supply medical commodities to this growing network in 1854. After the decentralisation policies of 1919, the All-India Institute of Hygiene and Public Health was formed in Calcutta in 1930. Furthermore, the development of rural health was formalised in Calcutta only after 1939. As of 1901, there was one hospital for every 850 square kilometers (Government of India (1909)) (The Imperial Gazetter, 1909).

Public Health Management in Native States

There is scant literature that details the institutional capacity of Native States within the period of British annexation. However, public health measures can also be proxied with the overall development of rural and urban spaces coupled with notable differences in property rights between the Native States and British Territories. Based on contemporary historiography of the period after 1858, I provide brief accounts of urban planning, sanitation, and public health management for a set of large and contiguous Native States.

Hyderabad State is a crucial example of non-conformity with the resident[3], and hence, the British Raj's policy of paramountcy. Contemporary historiography is congruous with this view, most notably Fisher (1991), Ramusack (1978), Copland (1997). The institutional capacity of Hyderabad State is at odds with up and downswings. Literature of the colonial period places administrative politics of Hyderabad as a conflict among the *mulkis*, or the indigenous educated class, and the *non-mulkis*, the modernized British gentry (Leonard (2003)).

The last Nizam of Hyderabad, Mir Osman Ali Khan (1911-1948), is credited with autonomously developing administration beyond the court and modernizing public good delivery. He also established Osmania University, the first in the region to use Urdu as the language of instruction instead of English. On the other hand, Leonard (2009) identifies the failure of Hyderabad to provide for electoral arrangements that delayed the political processes of group mobilization. Moreover, the State had no income tax which led to late development and a low level of municipal politics. Hence, institutional development beyond the court was visible only after the 1900s. Developments also included medical establishments at the end of the nineteenth century [4].

[3]Note here that *resident* refers to a diplomat from the British Raj present in the court of the native ruler, as part of the arrangements of indirect rule.

[4]Ronald Ross Institute, credited after Ronald Ross's discovery of a vector species of malaria. However, this credit does not explicitly go to

Mysore State, just south of Hyderabad, was equally cognizant of public health as the British Raj, and developed municipal institutions to ensure the management of congested and troublesome areas of its urban spaces, albeit at a slower pace. A primary focus of public health management was a careful quarantine of the plague and other epidemics in the subcontinent, and Mysore was privy to these issues. Bangalore, the capital, was divided into Princely and British jurisdictions (Dhanpal (2022)) [5]. The close proximity of direct and indirect colonial rule sheds historical light on the quality and magnitude of public goods delivery in this region. Institutions in the Princely jurisdiction such as the Bangalore City Improvement Committee, later absorbed into the Bangalore Municipality in 1889, were active in dealing with urban congestion and health initiatives. These developments further succeeded in the Mysore City Improvement Trust in 1903 and the Bangalore City Improvement Trust Board in 1904. Dhanpal (2022) reports that urban renewal and sanitation projects preceded the institutional developments in 1903-04, implying a prior recognition of public health issues almost in tandem with British Raj.

The Rajputana States Agency in Northwest India, synonymous with Mysore and Hyderabad, had a staggered convergence with health infrastructure. The region, largely arid in geography, owed its socio-economic issues with various monopoly rights to trade imposed by the British, coupled with multiple famines. Dispensaries and health centers first opened in the region in 1855. Over time, there was a remarkable increase in health services but this trend stagnated around 1904 (Erskine (1912)) (Provincial Gazetteers of India, 1912) [6]. Almost all hospitals and dispensaries were owned by *Darbars*, or the royal court administrators. Inoculation and vaccination rates varied considerably among the Native States of the Agency, with Jaisalmer State having a high rate.

An Overview of Modern-Day Health Policy

The present-day institutional setup of health policy was mainly a result of the 1966 Study Group on Hospitals conducted by the Ministry of Health and Family Planning. The system now consists of primary, secondary, and tertiary sectors. The primary sector comprises Sub-centres and Primary Health Centers which serve extremely rural and more developed rural regions. Sub-centers are fully funded by the national government whereas the latter falls under the purview of the state government. The secondary sector includes Community Health Centers and hospitals serving at the sub-district level, also funded by the state government. The primary and secondary sector hospitals and centers can also refer patients to the district hospital. Finally, the tertiary sector contains the All India Institutes of Medical Sciences which is managed by the central government.

The national level expenditure on health in India as a share of GDP is among the lowest in the world. Since the early 2000s, health expenditure is below 4% of GDP (2.96 % in 2020)[7]. While inpatient and outpatient care is covered by the government in the public sector, Indians largely depend on the private sector for healthcare which results in a sizeable out-of-pocket expenditure. This discrepancy arises from significant shortages of funding and resources in the public sector, which leads to a lack of access to quality healthcare for poorer households. Up to 37 % of Indians are insured [8]. Within this share, the lower quintile of households is insured under the National Health Protection Scheme. The remainder is insured under various employee insurance schemes and private insurer agencies. Despite various reforms to improve

Hyderabad, as Ross was a member of the British Indian Medical Service). Edwin R. Nye and Mary E. Gibson, *Ronald Ross: Malariologist and Polymath a Biography* (St. Martin's Press, New York, 1997), 67

[5]The division was Bangalore City, part of the Native State of Mysore, and the Civil & Military Station, which was under British jurisdiction. Both areas had independent Municipal Boards.

[6]The number of hospitals and dispensaries increased from 74 in 1881 to 178 in 1901, stagnating since. Also, note that the per capita availability of health services is very low in the period studied here.

[7]WHO Global Health Expenditure Database

[8]India Health Care System Profile, The Commonwealth Fund 2020

healthcare access at the public sector level, out-of-pocket expenditures are still more than 50 % of the total expenditure on health.

V. Relationships with Indian Health Outcomes

A crucial mechanism that shall explain the present-day trends of health indicators *on average* is the quality and persistence of health institutions contrasted between direct and indirect rule. Quality in this context also refers to the effectiveness of public goods delivery whereas persistence broadly implies the stability of the institution in place. A purview at the surface level indicates that the health institutions of the British Raj (as compared to Native States) were more effective, persistent, and stable. This argument can be supplemented with the fact that selective annexation of regional kingdoms was undertaken over decades since the late 1700s, leading one to believe that indigenous institutions and administration were under a state of flux. While British health institutions might result in a general trend of better health indicators, a closer look encompasses *who* benefits from British public goods delivery.

While health institutional development in the Native States was slow compared to British regions, there is evidence of a gradual convergence between colonial urbanism and development among Native States. Bhukya (2013), Copland (1997), and references therein are accordant with the British Raj's view that the Native States be pictured as backward conclaves while British India envisions modernity and mercantilist development. The authors aforementioned, however, notice a complete contrast of the Raj's perspective. Native States, in fact, ended up fostering cross-pollination of socio-cultural and political mobilisation from British-administered regions. Moreover, towards the end of the 20th century, native rulers also espoused colonial models of urban planning and administration [9].

As argued in the previous section and in Mushtaq (2009), health policy and institutions in British territories primarily served personnel of the East India Company, and later, the British Army. Harrison (1994) argues that the Indian Medical Service (IMS) between 1859 and 1914 had peculiarities that were biased toward British personnel. He reports that Indian medical officials were unable to exert universal occupational control over public health, primarily due to hostile attitudes by the British Raj. Moreover, British health policy was always at odds with indigenous medicine. The hostility between traditional and Western medicine culminated in the Medical Registration Act of 1858, which differentiated between legitimate and illegitimate practitioners of indigenous medicine. Complexities in the registration of medical practitioners further accentuated the issue of the legal status of medical professionals, which in turn rapidly declined the quality of educational standards in IMS recruitment.

There is also sustained evidence of segregation of tribal and backward communities in colonial urban planning. A crucial indicator that supports racial and tribal segregation is the Criminal Tribes Act of 1871. The British Raj defined a 'criminal tribe' as a diverse collection of marginalized peoples whom they regarded as criminals by hereditary caste occupation, including low-caste groups and people who were marginal to sedentary rural society. The quarantine of these tribes included mobility restrictions, forced displacement, or confinement in settlements. This Act was repealed in 1949, two years after Independence, and the tribes listed in the Act were denotified only in 1952[10]. These communities have sustained decades of isolation from public goods delivery, including access to healthcare. Historical associations have continued on to present-day isolation (Kannabiran and Singh (2008) Radhakrishna (2008)).

[9] This shift in indigenous attitude takes into account the influence of British residents in royal courts. Around the early 20th century, native princes and heirs apparent were often under the tutelage of the residents. Their inherited social capital also allowed them to venture into British models of the civil administration with a staggered reception among their subjects.

[10] As of the early 2000s, there are 313 Nomadic Tribes and 198 Denotified Tribes in India. A large portion of this community is still pastoral/nomadic in nature or is isolated in the same enclaves that were used to quarantine them during the British Raj. Some of these Denotified Tribes have not been conferred Scheduled Tribe status and are thus, absent from my analysis.

Present-day workforce regulation, educational training, and dissemination are evidently influenced by colonial-era policies. Sriram, Keshri and Kumbhar (2021) appropriately delineates the history of British Indian health policy and outlines the effect it commands over the issues that persist in independent India's health infrastructure, primarily its regulation. The best evidence that supports the aforementioned is the persistence of the Medical Council of India's (MCI) basic doctrines that are still in line with its formation in 1930 to its recent dissolution. Present-day challenges include the lack of a basic qualitative structure of training benchmarks, widespread corruption with regards to licensing private medical practices, and confused jurisdictions at the central and federal level [11].

The arguments above lead me to hypothesise a positive outlook of Indian health outcomes *on average* for regions that were directly ruled by the British Crown as compared to Native States. However, erstwhile inequities in healthcare access within British territories as outlined above lead me to suspect heterogeneities in health effects. The heterogeneity is suspected to stem from the current status of Scheduled Tribes, Castes, and Other Backward Classes.

VI. Data and Models

National Family Health Survey

Data for modern-day health outcomes are synthesised from the National Family Health Survey (NFHS) 2015-16, conducted by the Demographic and Health Surveys (DHS). The NFHS provides estimates for population health and nutrition in India, managed under the stewardship of the Ministry of Health and Family Welfare, Government of India. The survey is a stratified two-stage design. The 2011 census serves as the sampling frame for the selection of Primary Sampling Units (PSU). PSUs are villages in rural areas and Census Enumeration Blocks (CEBs) in urban areas. PSUs with fewer than 40 households are linked to the nearest PSU. Within each rural stratum, villages are selected from the sampling frame with probability proportional to size (PPS). In each stratum, six approximately equal substrata are created by crossing three substrata, each created based on the estimated number of households in each village, with two substrata, each created based on the percentage of the population belonging to scheduled castes and scheduled tribes (SCs/STs).

In all, 28,586 Primary Sampling Units (PSUs) are selected, of which fieldwork is completed in 28,525 clusters. In every selected rural and urban PSU, a complete household mapping and listing operation is conducted prior to the main survey. Selected PSUs with an estimated number of at least 300 households are segmented into segments of approximately 100-150 households. Two of the segments are randomly selected for the survey using systematic sampling with probability proportional to segment size. Therefore, the NFHS cluster is either a PSU or a segment of a PSU. In the second stage, in every selected rural and urban cluster, 22 households are randomly selected with systematic sampling.

Main Variables and Organisation of Data

The survey produces four questionnaires, namely, *Household Members*, *Men's Questionnaire*, *Women's Questionnaire*, and *Biomarker Questionnaire*. I use the first of the four listed above, which lists the usual members of the households. Since this questionnaire also lists any visitors who stayed in the residence the night before the interview, I filter those responses for my analysis.

[11] This issue stems from the issues of decentralising health policy since the Montgomery Reforms of 1919. Currently, the regulation of most public and private medical institutions is under the National Medical Commission, indirectly led by the central government. This restricts the regulatory power of federal governments. There is a lack of cohesion in autonomous legislation among these institutions, adding fuel to public health issues and overall personnel training.

The main outcomes of interest are defined and summarized below

1. *Body Mass Index* - BMI is defined as a person's body mass divided by the square of body height, measured in kg/m^2. A rule of thumb to describe general health using this indicator is
    a. *Underweight*, with a BMI under 18.5 kg/m^2
    b. *Normal*, with a BMI between 18.5 and 24.9 kg/m^2
    c. *Overweight*, with a BMI between 25 and 29.9 kg/m^2
    d. *Obese*, with a BMI over 30 kg/m^2
2. *Rohrer's Index* - Also known as Corpulence Index, it measures the leanness of an individual by using the third power of body height instead of the second. It is most commonly used in pediatrics and also provides better estimates than BMI, accounting for short and tall persons. The reference range is 12 kg/m^3 for individuals beyond infancy.
3. *Blood Glucose* - It is a measure of blood sugar levels concentrated in the blood, generally measured in molar concentration, mmol/L (millimoles per litre). Normal ranges of fasting glucose levels for non-diabetics is between 3.9 and 7.1 mmol/L
4. *Hemoglobin* - It is a transport protein in red blood cells that carries and releases oxygen throughout the body to enable aerobic transpiration. A healthy range is 12 to 20 grams of hemoglobin for 100 mL of blood.
5. *Blood Pressure* - It is the pressure of circulating blood against the walls of blood vessels. It is measured as systolic pressure (the maximum pressure in one heartbeat) and diastolic pressure (minimum pressure between two heartbeats). The standard unit is millimeters of mercury above surrounding atmospheric pressure. The normal range is 120 mL of mercury systolic over 80 mL of mercury diastolic.

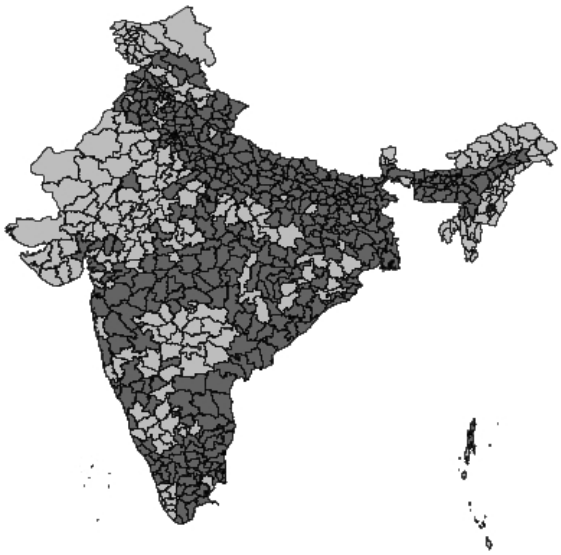
Measuring the impact of the health indicators above using absolute deviations from their normal range seems like a good method. However, the normal range for my outcome variables is within an interval rather than a single optimal value. Interpreting the effect of colonial rule on deviations from the optimal range warrants an analysis subjective to a range of demographic, geographic, regional, and cultural characteristics. Since I average out the household-level data, many of these features still remain unobserved and would ideally require a much more detailed analysis which is out of the scope of this project.

British Dummy Assignment

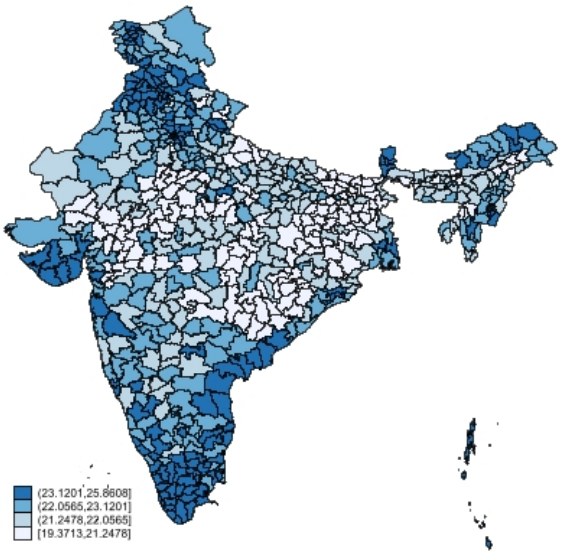
The survey records responses at the household member level. I collapse my data from the household member level to the district level using average outcomes. The survey uses dummy variables for the presence of household amenities, which are collapsed into mean proportions in each district. District boundaries and data on district-level geography are merged from the geospatial covariate database in the DHS spatial repository. Furthermore, Expanding the scope of Iyer (2010), all 640 districts as per the 2011 Census of India is divided using a dummy variable for British Rule, where the dummy equals 1 when the district was formerly part of British India. After the reorganization of provinces during Indian independence, some modern districts comprise several native states. Some districts also contain areas from both British Rule and Native States. Here, the British dummy is assigned 1 if a major part of the district belongs to British Rule.

Data for erstwhile British boundaries is taken from Baden-Powell (1892) and Provincial Gazettes. Within the period of British Rule, Provincial Gazettes are available for all modern states, the earliest from 1841 (Agra) and the latest from 1924 (Western India State Agency). The Pronvincial Gazettes are accompanied

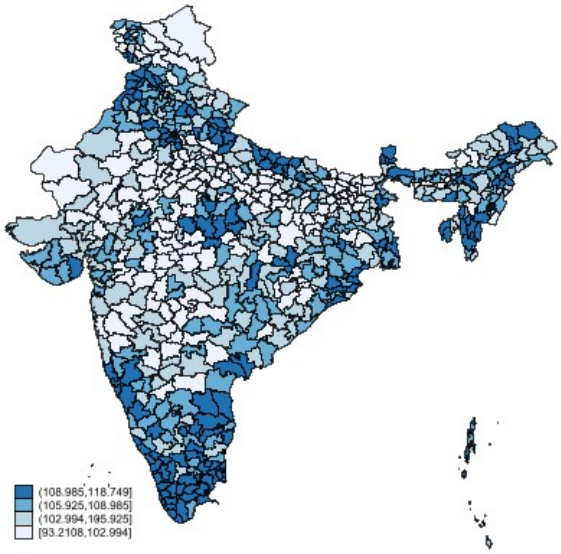
Figure 2. : Colonial India and Modern-Day Health at the District Level



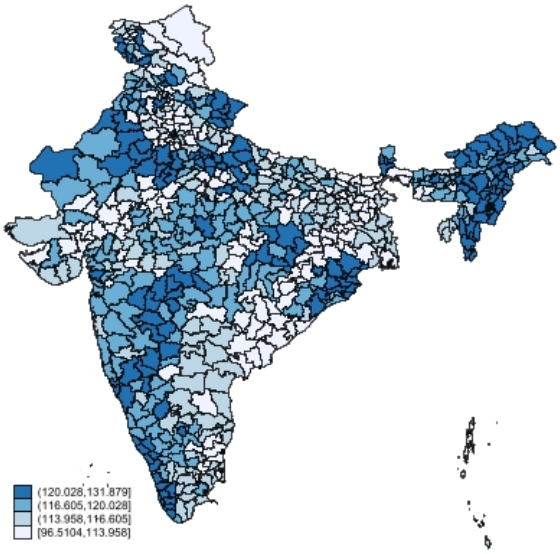
(a) British Raj in Dark Grey



(b) Body Mass Index



(c) Glucose Levels, mass concentration (mg/dL)



(d) Hemoglobin Levels, grams per decilitre (g/dl)

by the annals of the region's history and present-day administration. They also provide information on relationships with the British Raj. These Gazettes are then used with census reports of British Presidencies after 1847 to verify erstwhile colonial boundaries. The jurisdictions specified in the colonial documents aforementioned are identified across urban enumeration areas and then matched with post-independent district boundaries from the 2011 Census.

Figure 2 represents the distribution of health indicators averaged at the district level, contrasted with regions of direct British rule. At the outset, one can observe that regions under direct rule are associated with lower levels of mean BMI, especially North India and Bengal. A visual contrast of this association can be seen in Gujarat and West Rajasthan, which were under indirect rule for a sustained period of time. Another visual association is that hemoglobin on average tends to be higher in the erstwhile Native States. However, this association appears weak.

Endogeneity Bias in OLS Estimates

I initially run OLS regressions of the form

$$Y_i = \alpha + \beta \mathbb{1}\{i = British\} + \gamma X_i + \epsilon_i \tag{1}$$

Where Y_i is a health indicator for district i, and the variable of interest is a dummy for whether the district belonged to British Raj. X is a vector of primarily geographical variables and some household amenity controls. I correctly specify the survey design as provided in the DHS. I also account for the clustering of standard errors at the State level, to control for unobserved institutional differences at the federal level.

The regression (1) does not identify a causal effect of being in British-ruled territories. This is because of the self-selective annexation outlined in the sections above. For instance, the British Crown may end up annexing regions which were already better in agricultural productivity, geographical characteristics, or overall health indicators. Hence, the dummy assignment in (1) is potentially endogenous. Tables 1-3 show the test of means for a range of amenities and geographical variables for districts that were Native States and were under British rule.

The test of means further attests to the self-selection of British Raj into areas of the country. British-ruled territories have higher education levels and population density. Moreover, British-ruled districts have better access to household health amenities on average. Geographical features also show this trend, where districts under the Native States have higher aridity levels and significantly lower irrigation. British districts also have a lower mean slope.

Apropos the bias of the OLS estimates, there are two possible scenarios under the self-selection problem. First, the British may select themselves into regions that were already better at public health outcomes. Then, the OLS estimates will overestimate the causal effect. Second, the British may gain regions where the rulers did not adequately defend their kingdoms. This scenario may presumably overlook the already worse-off health indicators in these kingdoms, channeling into an underestimated OLS.

Table 1—: Test of Means for Demographic Characteristics

	Native States	British Rule	Difference	S. Error	N
Education	3.992	4.053	-0.061***	(0.020)	641
Population Density	552.712	1526.004	-973.292***	(281.378)	641
Hindu	0.669	0.793	-0.124***	(0.022)	641
Muslim	0.125	0.122	0.003	(0.014)	641
Christian	0.144	0.036	0.108***	(0.017)	641
Sikh	0.013	0.030	-0.017*	(0.009)	641
Scheduled Caste	0.142	0.201	-0.059***	(0.008)	641
Scheduled Tribe	0.284	0.125	0.159***	(0.022)	641
Other Backward Classes	0.304	0.417	-0.113***	(0.017)	641

Mean proportions at the district level reported, except Education and Population Density.

* $p < 0.1$, ** $p < 0.05$ *** $p < 0.01$

Table 2—: Test of Means for Health Amenities

	Native States	British Rule	Difference	S. Error	N
Sharing a Toilet	0.112	0.135	-0.023***	(0.006)	641
Mosquito Net	0.312	0.394	-0.082***	(0.027)	641
Piped Water	0.548	0.408	0.140***	(0.024)	641
Tubewell	0.228	0.448	-0.220***	(0.025)	641
Dugwell	0.095	0.088	0.007	(0.011)	641
Surface Water	0.042	0.013	0.030***	(0.005)	641
Flush Toilet	0.552	0.500	0.052***	(0.020)	641
Pit Toilet	0.110	0.090	0.020*	(0.012)	641
No Toilet	0.311	0.401	-0.090***	(0.022)	641

Mean proportions at the district level reported.

* $p < 0.1$, ** $p < 0.05$ *** $p < 0.01$

Table 3—: Test of Means for Geographical Characteristics

	Native States	British Rule	Difference	S. Error	N
Mean Rainfall	102.995	101.368	1.627	(4.353)	636
Mean Aridity	30.477	26.743	3.734**	(1.610)	636
Day Surface Temperature	30.097	31.192	-1.095***	(0.417)	640
Drought Episodes	5.829	6.364	-0.535**	(0.212)	638
Mean Vegetation	2769.812	2700.943	68.869	(56.012)	640
Gross Cell Production	2371.618	2255.542	116.077	(73.868)	641
Mean Irrigation	16.321	31.132	-14.811***	(1.996)	641
Nightlights Composite Index	2.959	4.176	-1.217*	(0.635)	641
Potential Evapotranspiration	3.942	4.055	-0.112*	(0.064)	636
Slope	2.745	0.870	1.876***	(0.224)	640

* $p < 0.1$, ** $p < 0.05$ *** $p < 0.01$

The Doctrine of Lapse

I solve the self-selection problem using Iyer's (2010) strategy. I argue that Lord Dalhousie's Doctrine of Lapse is an exogenous determinant of annexation. The policy was articulated as

"I hold that on all occasions where heirs natural shall fail, the territory should be made to lapse and adoption should not be permitted, excepting in those cases in which some strong political reasons may render it expedient to depart from this general rule."

According to this policy, eight Native States had rulers die without a natural heir during Lord Dalhousie's term in office. However, four States were annexed due to the Lapse - Satara, Sambalpur, Jhansi, and Nagpur. Annexation of the other four Native States was either reversed during Lord Canning's term or disallowed by the East India Company's court of directors[12]

Note that in each of the eight cases aforementioned, Lord Dalhousie wished to apply the Doctrine. But since annexation was disallowed in some cases, it implies that Dalhousie's choice of annexation was often beyond his control. Moreover, Iyer (2010) reports that in the period 1835-1847, fifteen rulers died without an heir, but only one of the states was annexed by Lapse. Thus, this policy was unexpected for the Native States. After the British Crown took over from the East India Company in 1858, the Doctrine was discontinued and the Native States were reassured against any annexation by Lapse. This provides strong evidence that this policy was an exogenous determinant of annexation since being unable to produce a natural heir within 1848-1856 is circumstantial.

The instrumental variable is defined as $\mathbb{1}\{i = Lapse\}$ if the Native State was not annexed before 1848 and the ruler died without an heir between 1848 and 1856. Note here that $Lapse$ cannot be assigned to areas annexed before 1848 since the British already ruled them. Hence, the dummy assignment $Lapse$ applies to regions not annexed on or before 1847. This instrument shall yield consistent estimates for the

[12]Annexation of Ajaigarh was reversed, Karauli was opted out of control by the court of directors. Orrcha was allowed to adopt an heir due to an agreement. Chhatarpur was permitted to place the king's nephew as the heir. See Appendices for the list of annexations.

British dummy assignment in regression 1 if $Lapse$ itself does not have a direct impact on outcomes. The first stage regression is

$$British_i = \delta_0 + \delta_1 Lapse_i + \delta_2 X_i + \eta_i \tag{2}$$

Where X is a vector of household, health, and geographical controls.

Table 4—: First Stage of IV Regression. Dependant Variable: British Dummy

	(1)	(2)	(3)	(4)
District Lapsed	0.282***	0.176***	0.172***	0.185***
	(0.050)	(0.054)	(0.053)	(0.054)
Household		0.423***	0.236*	0.229*
		(0.095)	(0.121)	(0.129)
Electricity Access		-0.888***	-0.740***	-0.743***
		(0.130)	(0.145)	(0.147)
Health Insurance		0.163**	0.135**	0.091
		(0.071)	(0.069)	(0.072)
Sharing a Toilet			0.480*	0.426
			(0.247)	(0.291)
Surface Water			-1.143***	-1.160***
			(0.298)	(0.289)
Flush Toilet			0.015	-0.003
			(0.119)	(0.127)
Smoke Daily			-0.317**	-0.361***
			(0.125)	(0.125)
Mean Rainfall				0.000
				(0.000)
Drought Episodes				0.015*
				(0.008)
Mean Vegetation				0.000
				(0.000)
F	32.45	30.83	22.40	19.02
R^2	0.0212	0.0965	0.1376	0.1412
Districts	641	641	641	634
Native States	45	45	45	45

Robust Standard Errors in parentheses
$^*p < 0.1$, $^{**}p < 0.05$ $^{***}p < 0.01$

Table 4 provides the first stage of the instrumental variable regression, with a range of controls defined above. The $Lapse$ dummy is a statistically significant predictor of whether a district is assigned to direct British Rule. Moreover, geographical controls do not predict British annexation (Column 4).

I compare the test of means under the endogenous British dummy assignment (Table 1-3) with the exogenous $Lapse$ assignment (Table 5). Table 2 shows that districts under direct British Rule have more health amenities in the household on average. Moreover, Table 3 shows better geographical features under direct British Rule, proving selective annexation. The means test for Native States versus districts under the Doctrine of Lapse, however, is largely insignificant. The significant differences of means under the endogenous treatment go away, showing more evidence of the exogenous instrument.

Table 5—: Test of Means of Controls for Native States and Lapsed Districts

	Native States	Lapsed Districts	Difference	S. Error	N
Household	0.285	0.237	0.049	(0.034)	641
Education	4.028	4.074	-0.046	(0.038)	641
Population Density	1204.179	785.909	418.270	(550.260)	641
Wealth Index	3.012	2.721	0.291**	(0.129)	641
Health Insurance	0.403	0.474	-0.071	(0.051)	641
Sharing a Toilet	0.126	0.134	-0.008	(0.013)	641
Surface Water	0.025	0.005	0.019*	(0.010)	641
Smoke Daily	0.321	0.347	-0.026	(0.024)	641
Mean Rainfall	103.497	80.138	23.359***	(8.364)	636
Drought Episodes	6.178	6.104	0.074	(0.410)	638
Mean Vegetation	2730.710	2654.249	76.461	(108.620)	640

$^{*}p < 0.1, ^{**}p < 0.05\ ^{***}p < 0.01$

Instrumental Variables Estimates

Table-6 and Table 7 summarise the OLS and IV estimates with the range of control variables presented in Table 5. The OLS estimates are generally upward biased and the IV estimates correct for this overestimation. On average, Body Mass Index, Rohrer's Index, and Hemoglobin show improvement for districts that were a part of direct British Rule. The IV estimates largely remain robust and unchanged after adding Household, Health, and Geographical Controls. On the other hand, direct British Rule cannot explain differences in Glucose and Blood Pressure at the district level. Apropos the regression specification, I broadly follow Iyer (2010) and only include state fixed effects as a robustness check to provide evidence for instrument validity. I also think that this work can improve with historical variables around the 1950s. Since my geographical controls are averaged from 1985, I think adding fixed effects along with more recent data is likely to accentuate specification biases.

Validity of the Instrument

The assumption that $Lapse$ is a legitimate instrument for British Rule means that $Lapse$ should be uncorrelated with the residual ϵ in equation 1. Hence, in the case when a ruler's death without a natural heir between 1848 and 1856 influences health outcomes for factors other than British annexation, then the instrumental variables are inconsistent. I attempt to support the legitimacy of my instrument using historical evidence and reduced-form regressions.

First, the instrument may be invalid if the Doctrine of Lapse was tailored to selectively acquire certain Native States. However, historical evidence does not point to this possibility. Lord Dalhousie wanted to acquire Awadh and Hyderabad but was unable to do so using the Lapse policy since these States had natural heirs. Hence, the policy was used to just acquire more regions without any targeted Native States. Second, the instrument is further endogenous if the East India Company conspired to assassinate certain regional kings. Moreover, one might think of native kings established taking over natural heirs to avoid their States

Table 6—: OLS vs. IV Regression Estimates: Summary with Controls

	BMI		Rohrer's Index		Hemoglobin	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
No Controls	-0.667	-3.350^{**}	-0.307^{***}	-3.399^{**}	-1.736^{***}	2.224^{**}
	(0.310)	(1.521)	(0.188)	(0.861)	(0.759)	(2.069)
Demographic Controls	-0.2504^{***}	-1.1524^{***}	0.237^{***}	-0.467^{***}	-1.773^{***}	5.69^{***}
	(0.310)	(1.283)	(0.188)	(0.822)	(0.759)	(1.801)
Health Controls	0.116^{***}	-0.788^{***}	0.164^{***}	-0.280^{***}	-1.634^{***}	9.225^{***}
	(0.212)	(0.880)	(0.144)	(0.753)	(0.682)	(6.311)
Geographical Controls	-0.0285	-3.027^{**}	0.084^{***}	-1.448^{***}	-1.766^{***}	7.351^{***}
	(0.266)	(1.503)	(0.073)	(0.798)	(0.769)	(5.568)
All Controls	0.148^{***}	-1.185^{***}	0.202^{***}	-0.472^{***}	-1.794^{***}	5.988^{***}
	(0.124)	(0.780)	(0.088)	(0.681)	(0.583)	(1.971)
Districts	640	640	640	640	640	640

Each Row represents the effect of British Rule and Robust Standard Errors in parentheses, clustered at the state level.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 7—: OLS vs. IV Regression Estimates: Summary with Controls

	Glucose		Mean Systolic Pressure		Mean Diastolic Pressure	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	*IV*	*OLS*	*IV*	*OLS*	*IV*
No Controls	0.027	-7.492^{***}	-0.122	-1.154^{***}	-0.253	-0.614
	(0.817)	(2.576)	(0.099)	(0.754)	(0.287)	(0.518)
Demographic Controls	0.476	-2.156	2.94	1.311	-0.164	0.362
	(0.619)	(1.780)	(0.580)	(2.098)	(0.245)	(1.723)
Health Controls	0.382^{***}	-0.476^{***}	-0.069	0.608	-0.267	-0.554
	(0.619)	(1.074)	(0.636)	(0.692)	(0.224)	(0.554)
Geographical Controls	-0.285	-6.177^{***}	-0.293^{***}	1.076^{***}	-0.357^{***}	0.166
	(0.664)	(2.792)	(0.099)	(0.908)	(0.097)	(0.691)
All Controls	0.514^{**}	2.313	-0.276	2.514^{*}	-0.372	1.135
	(0.388)	(2.320)	(0.518)	(1.802)	(0.202)	(0.603)
Districts	640	640	640	640	640	640

Each Row represents the effect of British Rule and Robust Standard Errors in parenthesis, clustered at the state level.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 8—: Reduced Form Regression: Robustness Check for Lapse Dummy

Dependant Variables	Baseline	State Fixed Effects
Body Mass Index	-0.034	-0.087
	(0.115)	(0.089)
Rohrer's Index	0.042	-0.024
	(0.074)	(0.058)
Hemoglobin	1.125	0.706
	(0.694)	(0.502)
Glucose	-0.099	-0.472
	(0.692)	(0.634)
Systolic Blood Pressure	-0.201	0.255
	(0.460)	(0.206)
Diastolic Blood Pressure	-0.090	0.060
	(0.313)	(0.254)
Controls		
Demographics	Yes	Yes
Health	Yes	Yes
Geography	Yes	Yes

Robust Standard Errors in parentheses

$^{*}p < 0.1, ^{**}p < 0.05 ^{***}p < 0.01$

being lapsed. However, historical evidence points to the sudden nature of the policy announcement and the fact that the regional kings never accused the East India Company of assassination. Iyer (2010) also mentions the possibility of a ruler's death being associated with bad geographical characteristics or hereditary issues that can directly affect outcomes. She is able to disprove this claim by adding dummies for a ruler's death with the reduced-form regressions as in Table 8. I am unable to digitize all data on ruler deaths due to time constraints, but I strongly suspect that the endogeneity claims above will fail to stand for my outcomes of interest. I also explicitly include state fixed effects to examine if state-level policies impact differences in direct and indirect rule. The estimates with fixed effects are insignificant.

The historical arguments above and the reduced-form regressions in Table 8 strongly lead me to believe that direct British Rule had a significant positive impact on mean health outcomes in the postcolonial period.

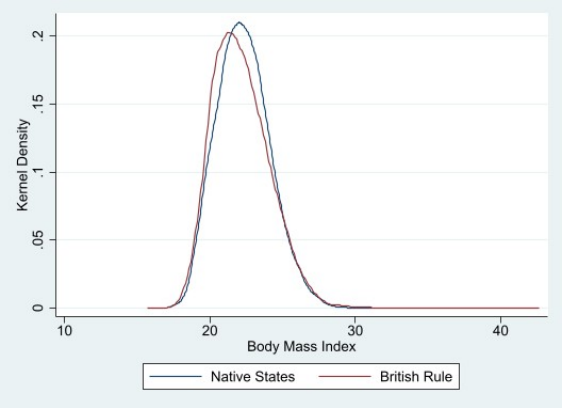
Effects Across the Distribution of Health Indicators

The distribution of health indicators, most importantly BMI and Rohrer's Index, vary across the age distribution. The importance of identifying treatment effects other than the overall average is that the total effect of being under direct British Rule can either come from the lower percentiles of the distribution or higher, or both. Here, one needs to assess the presence of potentially heterogeneous effects in two dimensions - mean health outcomes at specified quantiles of age and quantile treatment effects of health outcomes at specific age bins.

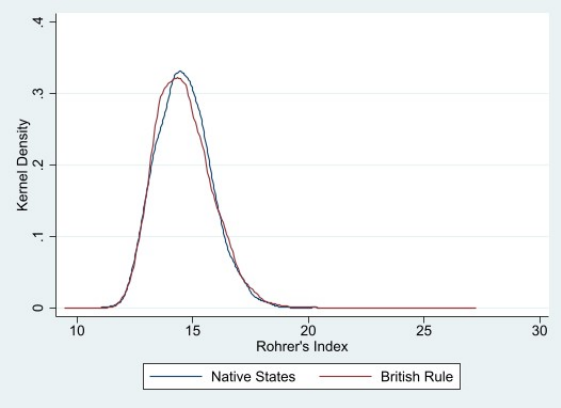
The distributional differences are visualised in Figure 3 and 4. Figure 4 shows that health indicators

in Native States may have a higher variability that British administered areas. At the two ends of the age distribution, i.e., the 25th and 75th percentile, the two distributions of BMI and Rohrer's Index are suspected to show two differences. First, the averages among observations under Native States for the two age percentiles are significantly different than observations under British Rule. This indicates a difference in location. Second, there might be significant variability of health outcomes across ages for the two types of administration, indicating a difference in shape.

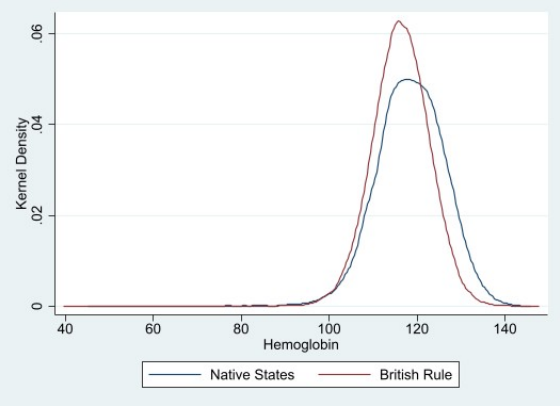
Figure 3. : Distributional Differences in Native States and British Rule



(a) BMI



(b) Rohrer's Index



(c) Hemoglobin

Table 9 presents how much location and shape parameters explain the difference in the distribution of BMI and Rohrer's Index at the 25th and 75th percentiles of age. Across the two percentiles for BMI, shape/variability contributes more than 90% of the differences in distribution between Native States and regions of British Rule. The same result as above holds for Rohrer's Index, where variability explains at least 69% of the differences in distribution. To understand the distribution of these outcomes beyond significant shape adjustments, I look at the relative PDFs of observations under Native States and British Rule to check for (under)over-representation of observations at the decile level of the two outcomes outlined above.

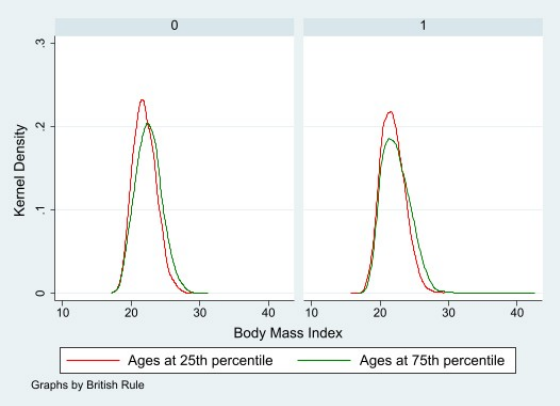
Table 9—: Kullback-Leibler Divergence for Health Outcomes: Native States vs. British Rule

	BMI at Age Percentiles		Rohrer's Index at Age Percentiles	
	(1)	(2)	(3)	(4)
	25%	75%	25%	75%
Location Shift	6.511	−9.841	−21.314	30.887
	(20.866)	(18.024)	(30.072)	(23.507)
Shape Shift	93.488***	109.842***	121.314***	69.112***
	(20.866)	(18.024)	(30.072)	(23.507)

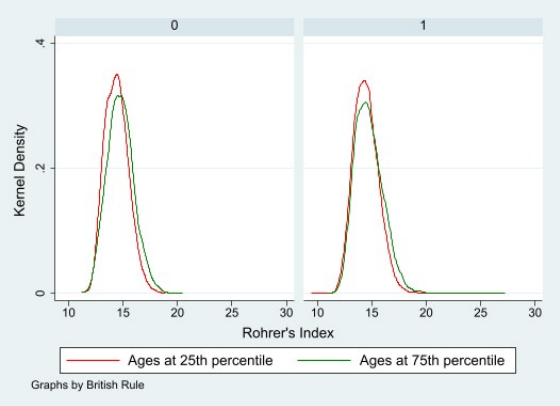
Robust Standard Errors in Parenthesis. Estimates in percentage units.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Figure 4. : Kernel Density of Health Indicators within Age Percentiles



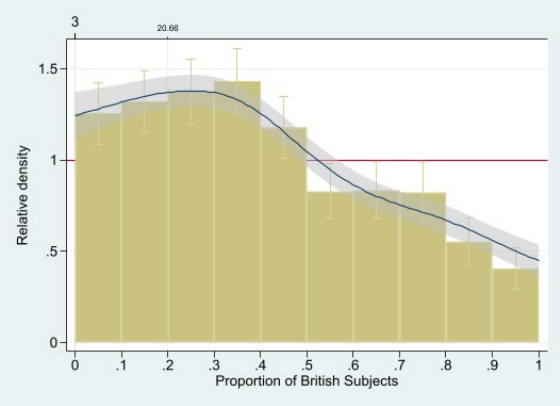
(a) Body Mass Index



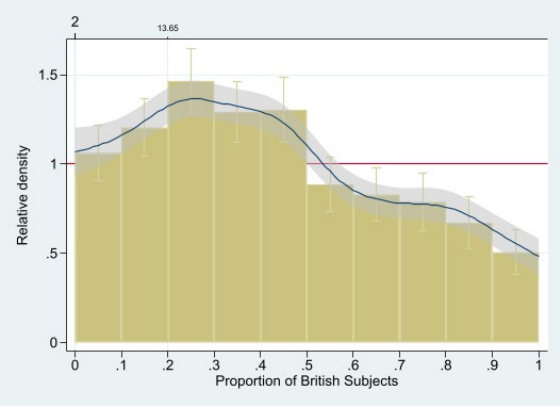
(b) Rohrer's Index

Note: The plots for each health indicator are divided into two panels, where Panels titled 1 are regions under direct British Rule.

Figure 5. : Relative Density of Health Indicators within Age Percentiles



(a) Body Mass Index



(b) Rohrer's Index

A relative density larger than one implies that observations under British Rule are over-represented in the corresponding level of the health indicator. Conversely, a relative density below one implies that observations under British Rule are under-represented. Figure 5 shows that for both BMI and Rohrer's Index, the largest distributional difference is below the median. At quantiles above the 60th quantile, observations under British Rule are significantly under-represented. This observation may also be interpreted as selective annexation by the British since the mean of health indicators based on under-representation is significantly different.

The distributional differences above motivate me to test the presence of heterogeneous effects of being under direct British Rule. First, I separately execute the IV regression outlined so far on samples below and above the median age. This will help examine which age demographics experience significant effects on (mean) general health. Second, I shall examine which quantiles of BMI and Rohrer's Index significantly contribute to the total effect of being in British Rule at the age quantiles specified above.

Table 10 shows the IV estimates of BMI, Rohrer's Index, and Hemoglobin at the 25th and 75th percentiles of age in my sample. The estimates show that the average effects of BMI and Rohrer's Index aforementioned are larger in magnitude for the 75th percentile. This means that the working population above the median contributes to a larger share of health improvements by being under areas of the British Raj.

Now, I examine which quantiles of BMI, Rohrer's Index, and Hemoglobin significantly contribute to the effects in Table 11 and Table 12, each for the 25th and 75th percentile of age. For both percentiles of age, BMI shows a significant improvement only for observations that are already overweight, i.e., with BMI above the median. Similarly, Hemoglobin significantly improves for observations that already have lower than median levels. Rohrer's Index shows a pronounced effect only for the aging sample.

Hence, I find that beyond the effect of British Rule on average health indicators can be further decomposed into two parts. First, only the aging quantile of the working population significantly contributes to overall health effects. Second, looking at the ages of the working population, already overweight households experience significant health benefits.

Do Lower Social Classes Enjoy Better Health?

Addressing my hypothesis for heterogeneous effects of being under direct British Rule, I restrict my sample to households who identify as a Scheduled Tribe at the NFHS Cluster Level and run the same IV regressions as in Table 6 and Table 7. The IV estimates for this restricted sample are summarized in Table 13 and Table 14 and contrasted with the full sample IV in Columns 2, 4, and 6 [13].

After controlling for the full range of household, health, and geographical variables, I find that Scheduled Tribes have benefited less than the full sample of households under direct British Rule. Tribal households experience a lower increase in Body Mass and Rohrer's Index. Moreover, British Rule cannot significantly explain Glucose levels and Systolic Blood Pressure. Compared to the IV for the full sample, the effect on Hemoglobin turns insignificant for the Scheduled Tribe sample.

[13]While the main treatment is at the district level, the estimates presented here are at the cluster level. One can argue a potential inflation of the treatment effect, but this serves as an upper bound of the true effect. Keeping this disclaimer in mind, I have used cluster-level data to reduce the variability of the estimates and to better understand the underlying distribution of the outcome variables.

Table 10—: IV Regression Estimates: 25th and 75th Age Percentiles

	BMI		Rohrer's Index		Hemoglobin	
	25 %	75 %	25 %	75 %	25 %	75 %
No Controls	-2.545^{***}	-3.524^{***}	-1.258^{***}	-1.870^{**}	6.519^{***}	3.822^{***}
	(0.260)	(0.266)	(0.178)	(0.174)	(1.019)	(0.918)
Demographic Controls	-0.441	-2.341^{***}	-0.059	-1.210^{***}	8.426^{***}	4.132
	(0.384)	(0.385)	(0.265)	(0.256)	(1.426)	(1.366)
Health Controls	-0.677^{***}	-2.216^{***}	-0.108	-1.106^{***}	7.528^{***}	4.786^{***}
	(0.256)	(0.270)	(0.175)	(0.182)	(1.072)	(0.994)
Geographical Controls	$--2.041^{***}$	-2.578^{***}	-0.884^{***}	-1.222^{***}	7.899^{***}	6.261
	(0.242)	(0.202)	(0.164)	(0.133)	(1.007)	(0.711)
All Controls	-0.679^{***}	-1.735^{***}	-0.066	-0.728^{***}	8.415^{***}	6.862^{***}
	(0.245)	(0.206)	(0.166)	(0.139)	(1.079)	(0.766)
DHS Clusters	28,525	28,525	28,525	28,525	28,525	28,525

IV estimates for subsamples in the 25th and 75th age percentile. Robust Standard Errors in parentheses.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 11—: IV Regression Estimates for the 25th Age Percentile: Health Indicators Above and Below the Median

	BMI		Rohrer's Index		Hemoglobin	
	50 %	> 50 %	50 %	> 50 %	50 %	> 50 %
No Controls	-0.240	-2.321^{***}	0.357	-1.182^{**}	5.79^{***}	1.576^{**}
	(0.220)	(0.316)	(0.189)	(0.219)	(3.259)	(1.373)
Demographic Controls	0.152	-1.455^{***}	0.316	-1.410	7.85^{***}	1.711
	(0.356)	(0.449)	(0.209)	(0.310)	(3.911)	(2.036)
Health Controls	0.119	-1.205^{***}	0.182	-0.89^{**}	6.36^{***}	1.728^{**}
	(0.247)	(0.292)	(0.179)	(0.201)	(3.054)	(1.342)
Geographical Controls	-0.073	-1.803^{***}	0.147	-0.866^{**}	6.470^{***}	2.034^{***}
	(0.222)	(0.286)	(0.192)	(0.196)	(3.13)	(1.335)
All Controls	-0.116	-1.035^{***}	0.162	-0.269	6.880^{***}	2.146^{**}
	(0.241)	(0.278)	(0.180)	(0.191)	(2.784)	(1.348)
DHS Clusters	$28,525$	$28,525$	$28,525$	$28,525$	$28,525$	$28,525$

IV estimates for subsamples below and above the median of health indicators. Robust Standard Errors in parentheses.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 12—: IV Regression Estimates for the 75th Age Percentile: Health Indicators Above and Below the Median

	BMI		Rohrer's Index		Hemoglobin	
	50 %	> 50 %	50 %	> 50 %	50 %	> 50 %
No Controls	-0.513^{***}	-2.503^{***}	0.131	-1.142^{**}	6.501^{***}	-1.497^{**}
	(0.193)	(0.496)	(0.121)	(0.303)	(1.499)	(0.579)
Demographic Controls	0.168	-3.440^{***}	0.115	-1.557^{***}	7.55^{***}	-1.59^{**}
	(0.277)	(0.763)	(0.180)	(0.487)	(2.191)	(0.708)
Health Controls	0.535^{**}	-2.219^{***}	0.025	-0.929^{***}	7.000^{***}	-1.076
	(0.211)	(0.484)	(0.135)	(0.292)	(1.562)	(0.614)
Geographical Controls	-0.472^{**}	-2.660^{***}	0.000	-1.246^{**}	7.118^{***}	-0.959
	(0.191)	(0.502)	(0.120)	(0.311)	(1.480)	(0.566)
All Controls	-0.699^{**}	-2.954^{***}	0.158	-1.350^{***}	8.361^{***}	-0.983
	(0.292)	(0.689)	(0.185)	(0.431)	(2.744)	(0.699)
DHS Clusters	$28,525$	$28,525$	$28,525$	$28,525$	$28,525$	$28,525$

IV estimates for subsamples below and above the median of health indicators. Robust Standard Errors in parentheses.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 13—: IV Regression Estimates: Sample Restricted to Scheduled Tribes

	BMI		Rohrer's Index		Hemoglobin	
	(1)	(2)	(3)	(4)	(5)	(6)
No Controls	-2.880^{***}	-1.114	-1.451^{***}	-0.798^{**}	$.561^{***}$	3.843
	(0.163)	(0.570)	(0.109)	(0.385)	(0.569)	(2.641)
Demographic Controls	-1.1524^{***}	-1.766^{**}	-0.467^{***}	-1.312^{**}	5.69^{***}	-1.399
	(0.219)	(0.750)	(0.147)	(0.521)	(0.801)	(3.02)
Health Controls	-1.283^{***}	-2.482^{***}	-0.496^{***}	-1.722^{***}	6.565^{***}	-2.565
	(0.163)	(0.862)	(0.111)	(0.588)	(0.631)	(3.96)
Geographical Controls	-1.185^{***}	-0.862	-0.472^{***}	-0.631	5.988^{***}	3.967
	(0.206)	(0.545)	(0.14)	(0.367)	(0.771)	(2.54)
All Controls	-2.415^{***}	-2.113^{**}	-1.119^{***}	-1.601^{**}	6.533^{***}	-3.885
	(0.154)	(0.999)	(0.101)	(0.702)	(0.568)	(3.65)
DHS Clusters	28,525	28,525	28,525	28,525	28,525	28,525

Columns 2, 4, and 6 represent IV estimates for the sample restricted to Scheduled Tribes. Robust Standard Errors in parentheses, clustered at the state level.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 14—: IV Regression Estimates: Sample Restricted to Scheduled Tribes

	Glucose		Mean Systolic Pressure		Mean Diastolic Pressure	
	(1)	(2)	(3)	(4)	(5)	(6)
No Controls	-6.555^{***}	4.647	-1.298^{***}	-1.455	-0.517	-3.792^{***}
	(0.99)	(4.389)	(0.530)	(1.911)	(0.518)	(1.408)
Demographic Controls	-0.25	4.371	1.311	-2.330	0.362	-3.894^{**}
	(1.365)	(3.387)	(0.709)	(1.896)	(0.723)	(1.573)
Health Controls	-4.314^{***}	7.971	0.931	-0.873	-0.327	-4.224^{**}
	(1.074)	(6.67)	(0.572)	(2.861)	(0.554)	(1.968)
Geographical Controls	-4.177^{***}	5.565	2.019^{***}	-1.456	0.180	-3.359^{**}
	(0.921)	(4.255)	(0.508)	(1.808)	(0.097)	(1.317)
All Controls	0.387	3.360	1.628^{**}	-1.879	0.526	-4.073^{**}
	(1.320)	(4.370)	(0.705)	(2.106)	(0.709)	(1.841)
DHS Clusters	28,525	28,525	28,525	28,525	28,525	28,525

Columns 2, 4, and 6 represent IV estimates for the sample restricted to Scheduled Tribes. Robust Standard Errors in parenthesis, clustered at the state level.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

VII. Discussion and Way Ahead

The results above strongly suggest that the colonial-era administration of the Indian subcontinent explains variations in health outcomes today. However, this project does not contain enough work to show transmission channels that explain the persistence of British-era health policy. I am only able to test that inequities to healthcare access based on low socioeconomic status have endured from colonial India. Thus, this section presents literature on the sources of inequities that are explained by the historical institutional setup of health policy and various extensions with which they can be directly tested.

The full sample results in Table 6 and Table 7 show an improvement in general health indicators by being under British Rule. This development of health *on average* can be contributed to the development of public health works by the British beyond the residences of British residents. This improvement in average health indicators can also be seen in Table 10 (at the 75th age percentile) and Table 11 (above the median), where the young working population does not experience any effects of British Rule and only the young overweight age quantile experiences improvements in health.

By the late 1850s, the British administration realised the need to expand health improvements to the general population beyond the sterile neighborhoods of British settlers. To that end, it employed various methods to sanitise other regions within their settlements and promote healthy habits. Sanitary work began in earnest only in 1859. A commission in 1863 promoted the development of a Commission of Public Health in each British presidency. Vaccination rates increased from 2.7% in 1881 to 3.5 % in 1903. The Epidemic Diseases Act was passed in 1897 to rigorously tackle infectious diseases. Note here that while the sustained nature of public works in the present-day shows a positive relationship between general health and the colonial administration, these enhancements were to identify and quarantine "unhygienic" communities and to maintain the health of the British Army. This argument is also supported by the fact that vital statistics for the general population became available only in the mid-1920s and widely discussed after in the early 1940s.

To understand the drivers of glucose levels and blood pressure and how British Rule may explain present-day differences, we need to look at how dietary nutrition in the general population was administered in the colonial era. My results show that British Rule cannot explain differences in glucose and blood pressure levels. Moreover, the OLS estimates show an endogenous selection of the British in regions of already higher glucose levels (Table 7, Columns 1 and 2). British India suffered major famines across the 19th and 20th centuries. But surveying and monitoring nutrition among the native population was not prioritised until the late 1930s, 72 years after the British Crown began directly administering the region. Durbach (2020) and Arnold (1994) write on British provisioning of meals for infants and the young population only as a result of widespread famines. Durbach further concludes that this measure was adopted only for the regulation of a sustained reserve of labour. Arnold mentions a compelling argument where the British administration provisioned diets only for sustenance, especially during famines. While the full scope of research on agricultural produce and consumption in this period is out of my scope here, the mere unavailability of infrastructure for basic nutrition can explain the current trends of undernutrition.

Banerji (1985) and Priya (2005) present compelling literature on the various sources of inequities in access to healthcare that have persisted from colonial India. A brief on these sources is also provided in Section V. Along with the authors above, Baru et al. (2010) provides salient features of the Indian health infrastructure that result from erstwhile British policies. The strength of the public health sector can be summarised at two levels. At the state level, there is considerable variation in the public capacity of health infrastructure. To that end, Kerala performs significantly better in basic and secondary health while Uttar Pradesh in North India is a consistently poor performer. Within the urban-rural level, British-era institutional capacity was very weak in rural regions. Present-day infrastructure still follows this trajectory,

wherein the skill capacities of the public health sector are considerably poor and the per-capita availability of free public sector care is low. Moreover, the deficiency of resources in the public sector is offset by a growing private sector which is increasingly unaffordable for lower-income quintiles.

As argued in Section V, the inconsistent regulation of healthcare at the central and federal level in the colonial era continues to this day, especially in the primary healthcare sector. The large prevalence of the primary sector in providing healthcare directly to rural households suffers from a lack of quality and resources (Uplekar, Pathania and Raviglione (2001); Kamat (2001); Jeffery et al. (2007); Jon Rohde (1994)). The lack of a well-functioning public sector from the colonial era aggravates health inequities when coupled with an unregulated and commercialized private sector (Bhat (1993); Sunder (1995); Motkuri, Vardhan and Ahmad (2017)). The lack of access aforementioned and colonial-era segregation of healthcare points to the presence of insufficient health gains as shown in Table 13 and Table 14. This result also provides micro-level evidence for caste/tribe-based discrimination in Indian healthcare (National Sample Survey Organisation (2006); Nayar (2007); Acharya (2010))

A direct way to test the access of households to public health infrastructure is to test the effect on out-of-pocket expenditures. Here, I can obtain health expenditures at the household level and attempt to explain its relationship with the dummy assignment in Equation 1 along with detailed historical information on the per-capita availability of healthcare (private and public). This specification would also require information on health insurance coverage across various government and private providers. While data on the latter are available in the NFHS used here, the full scope of analysis is excluded in this project.

The historical nature of the Doctrine of Lapse can impose further questions on the exogeneity of my instrument. While historical evidence shows the sporadic nature of the policy for a short period of time, the strategic placement of the Doctrine between 1847-1858 for territorial acquisition can support the argument that the British selectively annexed regions in the subcontinent. Moreover, there is some historical evidence of the British Crown deposing rulers or installing satellite states to support their administration.

I would like to go beyond this project in two primary ways. First, I wish to develop this thesis with a more micro-level perspective and better exogenous identification, where I examine institutional capacity across the Indo-Pakistan border made during the Partition of 1947. The borders of independent India and Pakistan underwent a relatively short-lived and rapid migration based on co-religious ties with the Native State of Kashmir subsequently embroiled in war. The geopolitical instability of the Kashmir region continues to this day where there is a heavy military presence in the Indo-Pak border and a strong quarantine of migration. Here, I wish to test the presence of health disparities using DHS datasets at the border. This work shall shed light on institutional differences between regions that were under the same administration before 1947.

Second, I would like to abstract from healthcare institutions and broadly cover colonial-era urban planning in the Indian subcontinent. I hypothesise that British-led urban development has a crucial role to play in the modern-day segregation of location choices and land prices in major Indian cities. I wish to establish this historical relationship and develop various transmission channels that preserve the persistence of colonial linkages.

VIII. Concluding Remarks

This project uses a historically significant policy of direct and indirectly ruled regions of British India to explain disparities in modern-day health outcomes. The annexation of a region upon the death of the native ruler without an heir provides an exogenous determinant of direct and indirect rule and controls for strategic selectivity in colonial expansion. The results presented are four-fold. First, the instrumental

variable estimates show improvements in general health outcomes when averaged across the age distribution. Second, these estimates also clearly highlight that the East India Company selectively chose regions to rule based on better health performance. This work provides further support for using exogenous identification for colonial literature. Third, the health improvements significantly accrue towards the aging working population on average and young populations with already worse-off health indicators. This provides strong support for overall health improvements. Fourth, households who identify as a Scheduled Tribe have benefited significantly less than the general population.

The results aforementioned are further supported by a careful analysis of historical literature. While British health policy performs better than the institutional capacity of Native States, I highlight significant shortcomings of British policy that have permeated into present-day policymaking. First, the historical segregation of socio-economically weaker households explains the deficient gains of Scheduled Tribes today. Second, I provide historical evidence that the preference of British health policy towards colonial settlers has led to a weak institutional capacity of present-day India. The latter shortcoming explains contemporary inequities to access healthcare. While testing these transmission channels is out of the scope of this project, I provide further arenas of research with better exogenous identification and a micro-level perspective into health disparities.

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Native States which were Annexed by the Doctrine of Lapse, 1848-1856

Native State	Year Ruler Died	Detail
Satara	1848	Kingdom created in 1818. The ruler was deposed in favor of his brother in 1842, annexed by Lapse in 1848
Sambalpur	1849	Handed over from the Bhonsla Kingdom to a local ruler (Maharaja Sahi) in 1818, passed over to the queen in 1827. Kingdom passed to relative Narayan Singh in 1883 after a regional insurrection. Annexed by Lapse in 1849
Jhansi	1853	Treaty with the British in 1804. Ruler died without natural heir in 1835 and in 1838 but succession installed by the British without annexation. State annexed by Lapse in 1853.
Nagpur	1854	Kingdom under British administration only until 1830 after the defeat of the Bhonsla ruler. Independence reversed via Lapse in 1854 after ruler died in December 1853.

Kingdoms where Rulers died without an Heir in 1848-1856 but were not Annexed

Native State	Year Ruler Died	Detail
Orchha	1852	The State had a prior agreement with the British in 1841 which allowed the Queen to adopt an heir. Lord Dalhousie did not annex on the grounds of a non-tributary state.
Karauli	1853	Recommended annexation denied by the East India Company's Court of Directors.
Chhatarpur	1854	Ruler succeeded by a nephew
Ajaigarh	1855	Ruler died in 1855 and the kingdom was annexed by Lord Dalhousie. The State maintained allegiance to the British during the 1857 Rebellion and hence, the state was returned to the adopted heir by Lord Canning in 1857.