Joerg Baten (U Tuebingen, CEPR, CESifo) and Laura Maravall (U Comillas, Madrid)

The Influence of Colonialism on Africa's Welfare: An Anthropometric Study

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Abstract

This study presents new evidence on the anthropometric development of 47 countries. Did colonialism have an influence on the biological standard of living of Africans? We find that Africans lost stature upon colonization, even after controlling for a number of different variables and potential sample selectivity bias issues. We analyse various types of colonialism and find that both settler colonies and other colonies had an adverse effect on native African heights during the colonialization period.

1. Introduction and related literature

In the following study, we assess height development before, during and after colonialism in Africa using human stature as an indicator for health and nutritional quality, or the 'biological standard of living'.[1] One common assumption in the historical literature is that colonialism reduced the standard of living of the colonized (Allen 2011, p. 102). Qualitative history and policy narratives share this view (as reported in Bertocchi and Canova, 2002). It is clear that the welfare component of the notion of 'political independence' is reduced under colonialism, and this by itself is sufficient to identify colonialism as immoral. However, the impact of colonialism on other components, such as health, income and education, during the colonial period has recently drawn more nuanced or optimistic views of the effects of colonialism. These views are mainly motivated by arguments such as the removal of internal slave trade institutions, the introduction of colonial infrastructure (such as railroads and roads), and investments in human capital (see the review by Austin, 2016). Most provocatively, Niall Ferguson (2002, 2011) argued that colonialism meant a modernization programme for the colonized countries and that the alternatives to colonialism were worse. In western Africa, for example, Ferguson points out that the initial political situation of the 19th century did not promise substantial development perspectives. The rulers in charge before the Western take-over were themselves engaged in the slave trade and would not have been likely—in Ferguson's view—to initiate the type of economic development that Europeans had achieved. The idea that these rulers or their successors would have adapted growth-promoting institutions later on is, in Ferguson's view, naive.

Other examples are provided by Heldring and Robinson (2012), who described the interpretations of colonialism coming from the far left of the political spectrum and the liberal

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[1] Komlos (1985) was the first to use the concept of the 'biological standard of living', which includes the height indicator function.

or right-wing part. On the far left, Lenin interpreted colonialism—and the type of imperialism to which the Western European powers switched during the late 19th century—as a modernizing force that provided the development level necessary for communism.[2] However, other early Marxist thinkers, such as Hobson, had a different view, seeing imperialism as immoral and unnecessary for economic organization (Hobson, 1902, new ed. 1965). More recent Marxist scholars such as Sender and Smith (1986) have also supported Lenin's view and stated that imperialism initiated a process of internal change in Africa, transforming the social relations within production and leading to, for example, the appearance of new land-tenure relationships, the creation of land markets, and the emergence of wage labour. On the other side of the political spectrum, some colonial administrators and scholars, such as McPhee (2012), shared positive views and argued that colonialism allowed for an economic revolution in West Africa.

This wide scope of differing views on the impact of European colonialism is partly explained by shifts over time in the theoretical approaches used to study economic growth in Africa. The Western, market-oriented theorists of the 1950s and 1960s stressed the relevance of physical capital; however, later attempts to build ironworks in Africa for producing machinery and other physical capital often failed (Austin et al., 2017). The emergence of Marxist thought in Africa in the 1970s was also heavily influenced by dependency theorists (Law, 1978) (see the review by Hopkins, 2019 and Ch. 1 in Austen, 1987), who stressed interactions with the developed world as a reason for the failure of developing countries to grow. Later studies have still focused on the role of direct exploitation during the colonial period, such as the removal of natural resources from colonies and the use of forced labour

[2] According to Lenin—who was heavily influenced by Hobson’s (1902, new ed. 1965) work—Imperialism is the highest stage of capitalism.

(Bairoch, 1993; see also Davis and Huttenback, 1988).[3]

Finally, market-oriented growth theory moved towards endogenous models in the 1980s and 1990s under the heading of 'new growth economics'. The proponents of this view emphasized human capital and institutional setups to explain why developing regions have lagged behind. The 'new institutionalist' economists stressed, for example, the adverse effects of the slave trade on interpersonal trust (Nunn, 2008; Nunn and Wantchekon, 2011) and the effects of artificial colonial boundaries on long-term economic development (Michalopoulos and Papaioannou, 2013).[4] Most of these studies, however, have focused on the persistent impact of early phenomena such as colonialism on the economic gaps of today (see review by Austin, 2010 and Hopkins, 2019). As an example, Acemoglu et al. (2001, 2002) famously argued that the disease environment for settlers attracted growth-inducing institutions in moderate climates and exploitative institutions in tropical world regions such as West Africa, having long-run effects on today's income disparities.[5] Another example is provided by Bertocchi and Canova (2002), who find that colonialism mattered for GDP growth. They show that the growth rates for six late-decolonized countries improved after becoming

[3] Forced labour was very widespread (sometimes as a consequence of very high taxation; see Frankema and Buelens, 2013; Frankema and van Waijenburg, 2018).

[4] See also the review by Hopkins (2019, p. 9-10).

[5] According to the authors, the exploitative institutional setup was then adapted by post-colonial indigenous elites. In contrast, the institutions established in colonies that were more oriented towards permanent settlement, also within Africa but most pronounced in the Americas and Australasia, had positive long-run effects because European-style, growth-promoting institutional designs were kept.

independent, although the evidence is somewhat mixed.[6] Somewhat more positively for colonizers, Grier (1999) found that the length of colonization had a positive impact on subsequent growth performance. The underlying mechanism in his view was that a more extended colonial history might have provided more stability within political institutions, but this holds only within the group of 63 colonized countries he assessed, as Grier himself emphasized.

This considerable disagreement on the impact of European colonialism has only been possible because quantitative evidence is scarce. For example, national income estimates can only provide very tentative insights. Several scholars have recently studied the real wage developments of labourers during the colonial periods to understand how living standards have evolved. Frankema and van Waijenburg (2012) estimated the real wage differential between African colonies and other countries in the developing world. For instance, in comparison with Japan and China, the West African colonies did reasonably well. Other case studies also support the positive view concerning the relatively high wages in Africa. De Zwart (2011) estimated real wages between 1835 and 1910 in South Africa and confirmed that real wages were similar to those of Europe and above those in Asia.[7]

However, real wage data in Africa are missing for pre-colonial times, and for colonial times, they represent only the wage-earning sector, which covers a small and potentially selective part of the whole economy (De Zwart, 2011; Frankema and van Waijenburg, 2012). For these reasons, scholars also rely on biological measures such as human stature to infer

[6] The database is limited by the fact that there are no reliable pre-colonial GDP estimates, and income evidence is scarce and not very reliable during and even after the colonial period.

[7] However, the author finds that living standards increased for Europeans and remained stable for Africans, thus increasing inequality.

past living standards. In the case of Kenya, Moradi (2009) found that the stature of military recruits first remained constant and then increased during late colonial times. Cogneau and Rouanet (2011) concluded that in Côte d'Ivoire and Ghana, heights increased during the colonial period (see also Moradi et al., 2013). In contrast, in the case of South Africa, Mpeta et al. (2018) argued that the living standards of the black population during the 20th century improved little, particularly during the first decades, because of repressive labour policies and land expropriations.

In this study, we use an extensive new data set on 47 countries that is based on the 'Clio Infra' data compilation project for which heights from all countries were collected (Baten and Blum, 2014). This project lasted for more than a decade because the aim was to avoid selectivity and measurement error as much as possible. The African height data set is analysed here for the first time. One of the attractive features of the resulting new anthropometric data set is the availability of evidence for birth decades before, during and after the colonial period. The core idea behind anthropometric studies is that average height is strongly influenced by the quality of nutrition, the prevalence of disease, and the level of parental care.[8] While the influence of genetic height maxima at the individual level is strong, averages of large height samples seem not to be strongly influenced by such constraints (Baten and Blum, 2014; Bogin 1991).

We study this anthropometric evidence on human stature across the African continent to perform a multi-country study for the first time. Our new data set contains 311 aggregated height values for African countries and birth decades that are based on 240,068 underlying individual height values. Our approach is to conduct a meta-analysis built on a large number

[8] There are two cases of rapidly industrializing countries—the UK and the US—in which heights and real wages diverged, but for the poor countries of the 19th and early 20th century, height is a good predictor of real income (Baten and Blum, 2012).

of studies that first processed these height values. We include both Sub-Saharan and North Africa (Table 1). The time span of our study starts with the birth cohort of the 1810s and ends in the late 1970s, as colonialism mostly ended in the 1960s and 1970s (at least officially). We then use evidence on the timing of colonialism to identify whether a country was a colony during a specific birth decade: some countries were colonized already in the 1880s, whereas other countries were not colonized before the 1900s or were not colonized at all (e.g., Liberia and Ethiopia, except for a short Italian interlude).

We find that, overall, the contemporary effect of colonialism was negative and significant with a height decline of at least 1.1 cm. Our results are in line with several hypotheses regarding the potential mechanism through which colonialism negatively affected development. First, agricultural land was expropriated in some regions, and hence, nutritional status became dependent on adverse and unfavourable labour market conditions. Second, and even more harmful for African welfare, was the widespread use of forced labour in many forms, not only in the extreme form practiced in the Belgian Congo (Frankema and Buelens, 2013; van Waijenburg, 2018). Third, the health development of Africans, especially during the early decades, was negatively impacted by infectious disease brought about by additional trade contacts and low investments in public health (Achola, 2001; Cole, 2015; Patterson and Pyle 1983; see also the final section 'Discussion and Conclusions'). Fourth, colonialism came with a number of conflicts that further reduced welfare (Gewald, 2005). We would expect that, compared to the previous period, the first phase of colonialism had a particularly detrimental effect because the economic structure was radically changed and conflicts were frequent. Finally, one potential determinant of height decline could be massive population growth; however, as our discussion in Appendix D shows, population growth was limited before the 1960s. Before the 1930s, decadal growth was never higher than 0.5% (Frankema and Jerven, 2014).

In this paper, we also distinguish various types of colonies. For example, we differentiate between 'settler colonies' and 'peasant export colonies'. This categorization is based on the previous literature, stressing the need to take into account the political context surrounding the type of settlement and allocation of land (see the review by Frankema et al., 2016, p. 6-8).

As a robustness check to our results, we also use an event analysis in which we only consider the height values in the decades immediately before and after colonization. The results confirm that colonization had a particularly adverse effect on the heights of indigenous Africans during the period of colonization.

Hence, this paper contributes to a recent body of literature that focuses on living standards during the colonial period (Moradi, 2009; Frankema and van Waijenburg, 2012; for a review, see, among others, Frankema et al., 2016; Fourie, 2016; Hopkins, 2019, Austin, 2010). It provides new evidence on anthropometric welfare across 47 countries before, during and after the colonial period. In doing so, it also adds to the research relying on anthropometric evidence to study long-term economic development (Moradi, 2009; Moradi et al., 2013; Austin et al., 2012; Cogneau and Rouanet, 2011; Stegl and Baten, 2009).

2. Data

Our sample covers the birth decades between the 1810s and the 1970s and relies on a large number of different studies (see Appendix A). For Africa during the late 19th and early 20th centuries, a large number of anthropological studies are available. Many of these studies have reported stature evidence for several ethnic units; hence, the temporal and geographical coverage is large. For example, in this study, we heavily rely on Hiernaux's (1968) work 'La diversité humaine en Afrique subsaharienne: recherches biologiques, études ethnologiques'.[9]

[9] See also Hiernaux (1976).

Hiernaux compiles anthropological information (see Figure 1) concerning 'well-defined African ethnic groups' that meet specific criteria, such as minimum sample size and the use of homogenous measurement techniques. The geographic coverage of these anthropological studies is quite comprehensive. We use Hiernaux as an encyclopaedia and collect additional information from the original studies cited by him.

However, the study of height trends based on early anthropological surveys has one drawback: the importance of identifying individuals by birth cohort was not yet fully understood by all anthropologists in the late 19th and early 20th centuries because they assumed that the physical measurements of a given population did not evolve from one decade to the next. The result is that, when depending on anthropological data, we have to estimate the birth decades for some of the samples. Based on studies for which a full age distribution is available, we find that most anthropological samples contained individuals who were on average 30 years of age. We assume this value for those anthropological samples for which the exact age distribution is not known. In these cases, the change in height accordingly results from earlier and later anthropological studies. For example, an earlier study from circa 1900 might refer mostly to the birth decade of the 1870s, and a later study from 1930 might refer approximately to the birth decade of the 1900s. Hence, we need to accept the possibility that a small proportion of those individuals identified as belonging to a given birth cohort in fact belonged to one of the two adjacent cohorts (the 1890s and 1910s in the latter example). Koepke and Baten (2005, 2008), Stegl and Baten (2009), and Baten and Blum (2012, 2014) succeeded in estimating average heights in such cases by similarly using a large number of studies that reflect in sum the changes over time.[10]

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[10] It should be noted, though, that time trends that result from such estimations resemble moving averages in that they smooth out the evolution of height averages. For example, if there was a height decline within a given population during the 1880s but only 70% of the

We also use the height data on slaves and liberated Africans. The latter were former slaves freed by the British who were intercepted on illegal slaving ships leaving Africa. Therefore, since one might argue that tall individuals were chosen more often to be slaves, we need to discuss the potential selectivity bias in the early 19th century liberated Africans' sample (Eltis, 1982; Baten and Blum, 2014; Austin et al., 2012).[11] Eltis (1982, p. 455) has argued that the height discrepancy between liberated Africans and the underlying population they came from was probably not substantial because height was not an important pricing criterion: while slave heights varied from region to region (for instance, Africans were tallest

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individuals in the data set from which we draw in order to analyse this decline in fact belonged to the 1880s cohort (the remaining 30% having been born in the previous decade), the decline would appear to be smoother than, in fact, it was.

Moreover, for an anthropologist to make statements about heights of different ethnic groups, it was important to measure not just a subsample of a village population but to try to include everybody from this village without any particular bias. This is relevant for the background of the discussion about volunteer armies and prisons for which it is a priori clear that not every individual was measured (for example, because volunteer armies did not accept persons shorter than the minimum height requirement, and prisons did not record the heights of those who were not sentenced to prison for a crime). Anthropologists wanted to make scholarly statements about the heights of different ethnic groups; hence, it was important for them to measure not just a subsample of a village population. Of course, there were sometimes practical obstacles (for example, women could not always be measured), but there were no principal reasons for measuring just a subset, as prison officials or volunteer army officers necessarily did (see Hiernaux, 1968, for a discussion of these issues).

[11] The following considerations are based on Baten and Blum (2014).

in Senegambia), regional prices did not reflect this variation (prices in Senegambia were not significantly different from those in other regions).[12]

Finally, —despite the lack of evidence on the labour market selectivity mentioned above, one could still argue that because of the Alchian-Allen effect, foreign slave buyers would select the tallest slaves (assuming that heights reflected quality). According to this theory, if one takes into account transport costs, better quality products become relatively cheaper for foreign buyers. However, as Eltis (1982, p. 455) points out, assuming that 'the preferences of the seller would be at least as important as those of the buyer' is to take 'a Eurocentric view of the slave trade'. This is because Africa's internal slave trade also required strong and healthy workers for plantations and other activities, such as canoeing and portaging on internal trade networks. That is, potential positive height biases between liberated Africans and the population from which they came were diminished by Africa’s own demand for the strongest (and, thus, presumably the tallest) workers available because Africa

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[12] See also Eltis (1979) for more detailed work on slave traffic and prices. Friedman (1982) finds that slave prices in the Caribbean were significantly different depending on the slave’s region of final residence. According to Friedman (1982), the slave price differentials between Trinidad and Jamaica of 64% reflected their productivity differences, as on Trinidad, sugar output per slave was 70% higher. For the price differences within the Caribbean, location was relevant (due to differences in factor endowments), not height per se. Moreover, in the Caribbean production centres during the 1820s, the situation was different from that of the African regions of origin that Eltis described because of the restrictions on the Caribbean inter-island slave trade brought about by influential abolitionist positions in England. Thus, as Friedman (p. 508, footnote 1) notes, the labour shortage determined prices on Trinidad in spite of its high productivity. However, this special situation in the Caribbean did not apply to Africa (Eltis, 1982).

was a labour-scarce world region herself.[13] Furthermore, a direct comparison of African soldiers' and slaves' height data, using a primary source from the early 19th century—namely, African recruits for military service in Indonesia—indicates that the latter do not suffer from a significant bias (Austin et al., 2012).

These studies, therefore, suggest that the heights of slaves are a reasonable (though not perfect) indicator of the population's welfare and are not affected by strong selectivity bias. Moreover, some internal validity checks between different slavery-related sources are possible to assess whether other issues of measurement error existed (i.e., unrelated to selectivity). For example, the liberated African data also seem quite reliable because slave height values in Sierra Leone (liberated Africans) and Havana (slaves) are substantially correlated (Appendix E). As some sceptical attitudes related to potential measurement error or the selectivity of slave evidence might remain, we also repeat the analysis below without including the slave-based height sources.

A final issue that could also potentially affect our results is survivor bias. Bozzoli et al. (2009) mentioned the potential effects of survivor bias in their comparison of African and South Asian heights. However, a large number of height studies have found that, for historical studies, survivor bias is less likely to have a substantial distortionary effect (and Bozzoli et al., 2009, p. 663, emphasized that their argument was a possibility rather than an evidence-based reality).

For instance, Moradi (2010) and Boerma et al. (1992) estimated that the effect of selective mortality on stunting for several developing countries was not substantial based on the height data of children who died or survived. Moradi (2010) found that heights would have decreased (due to the survival of the shorter children) by less than 1% if, instead of the

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[13] At the same time, there is no evidence that the slave market established anything like the military's minimum height requirement (Eltis, 1982)

high infant and child mortality in the Gambia during the 1960s, all children had survived up to age 5. Of course, such a dramatic change was not observed anywhere in the developing world (i.e., the complete disappearance of infant and child mortality in a developing country in the 1960s is not plausible). If there were a drastic 10% reduction in infant and child mortality from the level it had been in the Gambia circa 1960, it would only result in a 0.2 cm reduction in height due to reduced mortality selectivity. Hence, Moradi (2010) concludes that the effect of survivor bias was 'too small to explain much'. Moreover, for this survivor bias effect to explain the colonial height decline observed below, colonial health and nutrition systems would have needed to perform better than in pre-colonial systems. In our discussion of the few available pieces of information about health changes between the precolonial and colonial period, we find that this was probably not the case (see section 'Discussion and conclusion' below).

The data from the Demographic and Health Surveys (DHS) programme allow for trend estimates for most African countries during the period 1950-79, and there have been additional anthropological studies on the 1950s through 1970s to fill the gaps. The problem of potential survivor bias in the African data sets, which span the years 1945-79, has been intensively studied by Moradi and Baten (2005). They found that survivor bias was not very substantial (see also similar studies on survivor bias by Barro and Lee, 2013; Guntupalli and Baten, 2006).

Our data on the 1950s through the 1970s is mostly composed of female height. The fact that there is a strong correlation between male and female heights is by now beyond dispute (Baten and Murray, 2000; Moradi and Guntupalli, 2009), and it justifies why we can substitute one set of data for another.[14] We used the following estimation formula, which was

[14] We follow Baten and Blum (2014), who used this strategy first. Objections to this strategy might be raised by those who accept the female-resiliency hypothesis, which holds that for

identified by Gustafson and Lindenfors (2004), Moradi (2009b) and Baten and Blum (2014) as the most appropriate formula for Sub-Saharan Africa:

male height = (-6.72) + 1.11 * female height

(The coefficient on female height is significant at p=0.0000 with R^2 =0.97)

Institutions such as the DHS have studied child health and found that female stature was a crucial variable for understanding variation in child health. Hence, there is much evidence on female height beginning with the birth decade of the 1950s, which can be made consistent with the male data by using the formula above. Again, we also perform an analysis without this portion of the sample because sceptical readers might wonder whether the transformation of female into male height equivalents might potentially generate biases.

All these strategies have yielded a data set that has substantial coverage of African countries: for the 1810-1849 period, our evidence represents 19% of African countries and birth decades (weighted by population size). For the late 19th century, the share rises to 40%. In the 1900-1949 and 1950-1989 birth periods, the coverage is 77 and 86, respectively.[15] Altogether, we aggregated 240,068 underlying height observations into 311 country-birth decade units (Table 1 and Appendix A Table A.1).

One final concern regarding our dataset is the question of the role genetics may play in determining a given population's average height. This issue was often raised in the early years

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biological reasons the average height of a given female population is more resistant to adverse conditions than is that of their male counterparts. Some evidence from small pre-historic samples support this hypothesis. However, drawing on the largest height sample available to date, Guntupalli (2005) has gone far to disprove this hypothesis for the last two centuries. Since the vast majority of historical height estimates are for males, we transformed all estimates into male equivalents, following the estimation strategy of Baten and Blum (2014).

[15] These numbers refer to Sub-Saharan Africa.

of anthropometric research. In particular, for Africa, it has been argued that genetic diversity might be larger than in other world regions (for the following paragraph, see Moradi and Baten, 2005). However, in the anthropometric research of recent years, it has been found that while genes are a crucial determinant of an individual's height, for groups of individuals, genetic deviations from the mean tend to cancel each other out.

Moreover, there is considerable evidence indicating that environmental conditions, not genes, account for today's height gap between rich and poor populations, including those inhabiting a single nation. Habicht et al. (1974), for example, found that the height gap between the rich and poor sectors of a less-developed country (LDC), Nigeria, was even wider than that between the LDC's elite population and a reference population in the United States.[16] Fiawoo (1979), in his study of Ghana, reached the same conclusion as Habicht, as did Eksmyr (1970), working with data on several Ethiopian ethnic groups, and Graitcer and Gentry (1981), when they considered Egypt, Haiti, and Togo. Moreover, the height-distribution percentiles for children from wealthy families in this last study are in line with those for a rich country, namely, the United States.

In sum, the height data for African countries pose some challenges and contain a certain amount of measurement error, but strategies have been developed to make this data a useful basis for studying welfare trends and differences, as we do in the following sections.

3. Direct effects of colonization

Our methodology to assess the effects of colonization is relatively straightforward in principle: we use the existing studies that list colonial relationships to create an indicator variable. Olsson (2009) is the standard reference for this, although Henderson and Whatley (2014) recently suggested a region-specific data set that we also use. If there was evidence

[16] The following review of the literature is based on Moradi and Baten (2005).

that the country was de facto colonized during a specific birth decade, we coded the respective variable as one, and we coded it as zero if the country was not colonized (either because it had not yet been colonized or because it had already achieved independence). We then assigned the information to all countries and birth decades for which we have anthropometric data. However, the identification of which countries were colonies turned out to be anything but straightforward. Many countries (such as Senegal) had early trade settlements on the islands near the mainland, and only over time did the mainland become increasingly colonized.

In some cases, only a part of the territory of a modern country was colonized. For example, Ghana was divided into the Gold Coast colony, the Asante kingdom and the Northern territories during the 1880s. During the late 19th century, today's South Africa consisted of the South African Crown Colony, as well as the Orange Free State and other parts, which were formally independent (although partly occupied by white settlers). In other cases, countries were officially colonies, such as Chad beginning in 1908, but the colonizers did not organize a thorough colonial administration until somewhat later. Given all these difficulties in classifying colonial status, we use the second classification of this core variable using Henderson and Whatley's (2014) definition of colonial status.[17] The main difference between both sources is that Olsson (2009), on the one hand, provides the 'official' dates of colonization, sometimes dating them as such before the whole territory was effectively governed as a colony. On the other hand, Henderson and Whatley (2014) take into account the territorial process of systematic colonization, that is, the concurrent importing of laws, institutions, and customs from the colonizer countries', seeking to capture 'the marginal effect of systematic colonial administration of the land, rather than something like an "outside

[17] We also performed the analysis based on Grier (1999, p. 334), who distinguishes the African countries by colonizing power and includes 31 African countries.

contact" effect or a "commercial contact" effect' (Henderson and Whatley, 2014, p. 10). Using both concepts of colonization, we can be relatively sure that we capture the various impacts of the colonization process.

In Table 1, we show the number of underlying observations by country and birth decade included in our study. We also add information on colonial status using Henderson and Whatley (grey shaded) and Olsson (plus and minus signs). The country for which the earliest height data are available and for which we classify a colonial relationship according to both classifications is Mozambique in the 1810s. In contrast, for this period, Henderson and Whatley (2014) document thirteen independent countries, while Olsson adds four more colonial countries and classifies only ten as independent (indicated by plus signs). Except for this first decade, Henderson and Whatley and Olsson agree on most cases.

During the 19th century, the larger number of observations refers to independent countries, whereas colonized country-birth decade units dominated the early 20th century. Between the 1900s and the 1950s, most African countries were colonized, the exceptions being Liberia and Ethiopia (despite the Italian interlude of 1936-42). During the second half of the 20th century, colonial evidence comes predominantly from the 1950s and 1960s.

We aggregate height by colonial status, country and half century in Table 2. We are using half-century aggregates here to provide a first overview impression of the height differences between colonial and free states. For example, we assign the birth decades of the 1850s to the 1890s to the second half of the 19th century. The most important result is that in each of the half-centuries, the heights of the colonized countries on the right side of the table (bottom line) were lower than the heights in independent countries on the left side. During the later 20th century, the heights were almost identical: the independent countries had an average height of 169.9 cm, while the colonized countries had a slightly lower average of 169.8 cm (on the low increase or even decline after independence, see Moradi, 2009). For the two centuries as a whole, we observe a gap of 0.8 cm, which is a significant amount in the historical height literature (Baten and Blum, 2012).

In Figures 2 and 3, we show the height values in two maps, both referring to the core time frame of the 1850s to the 1940s, but Figure 3 shows the differences in height between the precolonial and colonized countries. Figure 2 illustrates that height levels were high in the Sahel zone between Senegal and Somalia. We observe in Figure 3 that in a substantial number of countries, heights decreased during colonialism (the darker areas). The decline was most extreme in the Belgian Congo (the later Democratic Republic of Congo, or DRC), the Central African Republic (CAR), Somalia, Eritrea, Egypt, and Guinea. Only Niger, Cameroon and Togo had positive development between precolonial and colonial times. The Democratic Republic of Congo experienced a substantial decline of not less than 1.6 cm (from 165.7 to 164.1). A very substantial colonial height decline of between -1.0 and -1.5 cm was also observed in Tanzania, Burkina Faso, Congo-Brazzaville, Mali and Libya, and a modest decline of less than 1 cm was observed in six other countries. For our analysis, it is relevant that the colonial height decline was observed in all regions of Africa (although of course not for all countries). If this had been a very localized event of height decline, then the probability of an unobserved variable causing it might be higher as local unobserved variables are more frequent than continent-wide variables that go unnoticed. The history of colonialism implies that the height values of the independent country map refer more often to the 1850s to 1880s period (very few are from later decades, see Table 1). As heights increased during the 20th century in other world regions (Baten and Blum, 2014), values of zero change in Figure 3 would have signalled a negative health effect of colonialism.

4. Baseline regressions

We report descriptive statistics for the data used in the following regressions in Table 3. Height differed substantially between a minimum of 160.5 cm and a maximum of 174.7

cm, while the average height in Africa for the cases observed was 168.2 cm. 70% of our observations are classified as a colony during the decade of observation.

We now turn to regression analysis using the unit of birth decade and country. The baseline regression specification is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \gamma_2 T_2 + \ldots + \gamma_t T_t + \alpha_i + u_{i,t} \quad (1)$$

In Equation (1), the outcome of interest, $Y_{i,t}$, corresponds to the heights in each country i and birth decade t. In this equation, we also include time dummies: T_t is a binary variable for each birth decade, and we have t-1 periods in the model. $u_{i,t}$ is the error term. $X_{i,t}$ is a vector that contains a time-variant variable that measures colonization ('Colony ', 'Colony (incl. first dec.)', and 'Colony (Henderson/Wh)', alternatively). In the various regression models, we later add control variables to this basic specification.

We implement various specifications to assess the robustness of our results (see Table 4). For example, in Column 1, we estimate a simple country fixed-effects model with only the variable ‘Colony’ and time fixed effects.[18] Next, in Column 2 (and all the following specifications), we add a control for the number of cattle per capita (‘Cattle p.c. (log)’). The evidence on cattle per capita was estimated by Kees Klein Goldewijk within the Clio Infra

[18] The introduction of colonialism was in reality not a 'one decade to the next event'; that is, it is not the case that heights dropped in the decade when colonialism was introduced and stayed at this lower level until colonialism was overcome later. Rather, it was a process that started at a certain point but then developed over several decades. We perform a t-1 test in Appendix B (i.e., we lag the explanatory variable ‘Colony’ by one decade) and find that the effect is certainly weaker and insignificant.

project and is available by decade and country.[19] Earlier studies have shown that cattle per capita is a variable with high levels of explanatory power for height (Baten and Blum, 2014). Earlier research has often found that proximity to protein production has nutritional benefits (de Beer, 2012; Baten, 2009). For example, Ethiopia had a very high number of cattle per capita and very high height values. It is also essential to control for cattle numbers, as colonial economic integration could have increased the likelihood of dramatic *Rinderpest* (cattle plague) events because cattle were often transported. During the 1890s, East and later South Africa suffered from terrible *Rinderpest* epidemics that resulted in a catastrophic famine in many regions—although the epidemic admittedly did not stop at colonial borders (Ethiopia was among the countries that suffered most, see Spinage, 2003). Only after controlling for cattle per capita can we ensure that a potential colony effect is associated with a decline in height.

In Column 3, we change the measure of colonization so that it now includes the first decade of colonization ('Colony (incl. first dec.)'; Table 4). In the previous specifications, we excluded the first decade because one could imagine that the coefficient reflects not colonization by itself but rather the conflicts that mainly took place in the first decade of colonization. We want to adopt a lower-bound assessment of the colonization effect in most of the regressions, but here we vary this specification. Apart from conflicts, we could imagine that the first one or two decades of colonization were also a particularly difficult period of adjustment to a new economic system.

In Columns 5 and 7, we only focus on the early parts of the sample to study the effects between the period before colonization and the first decades of colonization (until the 1910s). We also include one specification in which we drop the slave sample of the early 19th century

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[19] Available at https://clio-infra.eu/Indicators/CattleperCapita.html (accessed November 2, 2020).

(Column 4). On the other hand, we think that it is an advantage to include the slave sample in general, as we found above that it was not systematically biased and a larger sample allows for better inference than a smaller sample.

Finally, as a robustness check of the 'Colony' variable, we use Henderson and Whatley's (2014) classification of colonization ('Colony (H&W)') (Table 4, Col. 6 and 7). In Column 7, we also drop the later parts of the sample (including and after the 1920s).

In Table 4, we show the results of our various specifications. We can see that a country that was a colony at a given point in time had a 1.08 cm lower height, even after we control for the country and time fixed effects. The adjusted R-squared was also relatively high, with a value above 0.5 in all regressions.

If we add cattle per capita, the difference is not very large (Column 2). If, as in Column 3, we include the observations belonging to the first decade of colonization, which was usually associated with conflicts (or, at least, substantial adjustment costs for a newly colonized territory), the coefficient increases and remains significant at the 1% confidence level. That is, people under colonial influence were as much as 1.61 cm shorter than those in non-colonies or in the periods before or after colonialism. In Column 4, we drop the slave sample and find that the colony coefficient is still approximately the same size.

Which period mattered most: the period before colonization or the period after colonization? Did the decolonization experience perhaps cause the colonial effects? In other words, were heights growing after the independence wave of the 1950s and 1960s, which brought independence to the majority of African countries and hence caused the negative effect of colonialism on height? The regression results indicate that the effect was driven by the period before independence. In Column 5 of Table 4, we include only the period before the 1920s. The coefficient is still significant and becomes even larger: 1.7 cm higher than that for the overall sample. Of course, the number of cases declines if we only consider the periods up to the 1920s (N=112). This latter robustness test also implies that the results are robust to excluding the male height equivalents that were calculated based on female heights, as all of these were recorded for post-1950 birth decades that were dropped in Column 5.

Finally, the negative results of colonization are confirmed if we use Henderson and Whatley's (2014) alternative classification of colonization for both the full and the early sample before the 1920s (Columns 5 and 6).

In Table 4, we performed weighted least squares (WLS) regressions, weighted with the population size in 1950 (also obtained from the Clio Infra project and based on the latest estimates from Frankema and Jerven, 2014). For example, the large country of Nigeria receives a larger weight than the small country of Equatorial Guinea. This is repeated in Column 1 (Table 5). In Column 2, the weights used reflect the number of cases that are underlying each birth decade and country-specific observation so that the better-documented cases receive a stronger weight. We also use the square root of the underlying number of observations (Column 3), and we use no weights in Column 4 (Table 5). For this comparison of different weighting procedures, we use observations up to the 1940s, that is, before the large data sets of the 1950s-1970s begin. If we include these post-war data, their large numbers of cases would dominate the estimation in Columns 2 and 3 in a non-proportional way, assigning almost no weight to the late precolonial and early colonial period and nearly all weight to the post-war period.[20] All four different weighting procedures yielded the same

[20] Admittedly, we have only a relatively small number of underlying observations for the birth decades before colonialism began (Table 1). Hence, weighting by the underlying observations yields a slightly smaller coefficient for colonialism, as it reflects the large number of underlying observations that we have for the colonial period and assigns only a very small weight to the few underlying observations that we have for the pre-colonial period.

colonial height effect, indicating that colonialism was very detrimental for height development.[21]

5. Types of colonies: settler and peasant export colonies

In this study, we also consider the various types of colonies. A substantial body of literature has discussed the different colonial experiences between peasant export colonies and settler colonies. The 'settler' type of colony was characterized by a minority of settlers who coexisted with a large local population and relied on the colonial administration to access land and labour. The government reallocated a substantial part of the cultivable land to the settler population. These colonies differed from other types of colonies in which, for example, African smallholder farmers maintained control over the land ('peasant colonies') or in which most of the land was allocated to European estates and large plantations ('plantation' or 'concession' colonies). However, we have no height data from the plantation-oriented countries of Mauritius or São Tomé and Príncipe (for more detailed classifications, see Austin 2014, p. 315; see also Lloyd et al. 2013, c. 1 and c. 5).

In our study, we use a broad definition of 'settler colonies': any colony for which the literature has documented a substantial impact of European settlers. We do this because sometimes having even a small number of settlers could have serious consequences (see below). Acemoglu et al. (2001) compile (in the appendix to their paper) evidence on the European population in African countries (which consisted mostly of settlers). Their study is based on Curtin et al. (1995), who estimated the share of Europeans in 1900 and 1956. Of course, this does not cover the settler colonies in which the settlers of the early 20th century had disappeared by 1956. Apart from obvious settler colonies such as Algeria, Kenya, Namibia, South Africa, and Zimbabwe, this data set also notes substantial numbers of

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[21] We thank the anonymous referees for suggesting that we use different weighting schemes.

European settlers in Angola, Malawi, Mozambique, Tunisia and Zambia either in 1900 or 1956.[22]

Moreover, as less data are available for former German and Italian colonies, Namibia and Eritrea are not classified as countries with substantial numbers of settlers, although these were colonies with a strong settler element. Even today, many people of European origin live in Namibia. For German East Africa, which covers today's Tanzania, Gewald (2005) has recently described the settler economy and the atrocities associated with it. Although the European settlement element was not large, it still had an impact on the economy of the inhabitants of African descent. Tanzania is a clear example, given that the German settlers recruited almost one-quarter of the total male labour force during the colonial period before World War I (Gewald, 2005).

How did heights develop specifically in settler colonies before and after colonization? We will briefly discuss some examples for which data are available, namely, Kenya, Malawi, Tanzania and Eritrea. One of the classical settler colonies was Kenya, with substantial land expropriation in favour of mainly British settlers. For Kenya, the 1880s average height level was 167.9 cm, and for the early colonial birth decades between the 1900s and 1920s, it was almost identical, 167.7 cm (based on Moradi, 2009, and the standardization effort in Baten and Blum, 2014). In Malawi, which also had a small number of European settlers, average heights remained identical between the 1870s and the 1920s-1940s (Baten and Blum, 2014). However, at the same time, global heights increased substantially: Baten and Blum (2014) estimated that between the 1870s and 1920s to 1940s, stature in the world increased by no less

[22] In this categorization, we would also include Mauritius and Reunion but there is no data available. In the case of South Africa, which was a clear example of a settler economy, we only have observations for the period after 1920. We also add Eritrea to the list of settler colonies, although Curtin et al. (1995) did not study North-East Africa.

than 1.6 cm, whereas between the 1880s and the 1900s to 1920s, it was 0.9 cm. The estimates by NCD Risk were even more optimistic, reporting an increase of 1.9 cm between the 1890s and the 1900 to 1920s (NCD Risk, 2016). In other words, the very modest decline in Kenya equals a substantial loss relative to the general world trend. Moreover, in Kenya, the negative height effect was perhaps limited in size because the British educational system might have compensated for the adverse impact of land-grabbing, forced labour and conflicts between the colonizers and the colonized to a certain extent. That is, the impact of land-grabbing and forced labour due to the colonial settlement was negative, but the advantages of the educational system might have partly counterbalanced this effect (Frankema, 2012; Cappelli and Baten, 2016).

In contrast, neighbouring Tanzania (or Tanganyika or German East Africa) was characterized by a fierce colonial system that evoked massive conflicts, especially the Maji war, but several other military conflicts as well. The colonial power took revenge for upheavals, as recently described by the Dutch historian Gewald (2005). Furthermore, Tanzania was also hit by the Rinderpest in the 1890s, the conflicts during World War I and the influenza epidemic. These events resulted in a low population level, such as in the case of the Iringa region. This region seemed almost 'empty' to the British Colonial administration in the 1920s after they took over control following World War I. Consequently, a substantial number of European settlers went to this region and expropriated the land. Although Tanzania received fewer settlers than Kenya, the height effects of European colonization and the other factors (e.g. influenza, a world war) were quite drastic (Figure 4). In Tanzania, we have one of the best height records, as many waves of measurements were taken for many distinct ethnic groups. We observe a decline from the 1880s to the 1910s by more than 3 cm and not much recovery until the 1960s. The combination of conflict, infectious disease among humans and cattle, the expropriation of land, and forced labour resulted in this extreme decline.

Another settlement colony whose economic historiography is not very large is Eritrea, an Italian colony beginning in the 1890s. The Italian government aimed to redirect the Italian immigration movement away from the Americas and encouraged new settlement in their territories in North-East Africa. Although this was not very successful, the Eritrean African population was still severely affected by European settlement and land grabbing. Italian anthropologists observed relatively tall Eritreans who were born between the 1850s and the 1880s, whereas the heights of those born in the 1890s and 1900s were substantially lower (Baten et al., 2020).[23] A later survey for the birth decade of the 1920s and later captured a gradual recovery of height, but the previous levels were not reached until the 1950s. For other African settler colonies, we do not have height evidence from directly before and after colonization.[24] However, looking at the four settlement colonies for which reliable data are available, we can identify either a drastic decline in heights on average (Tanzania, Eritrea) or at least worse development than that illustrated in the global height records (Kenya, Malawi).

Table 6 displays the results taking into account the different types of colonies. The specification is similar to Equation (1)—that is, a fixed-effects model with time dummies—but this time, we use different variables to measure colonization.

Turning to the results, in Column 1 of Table 6, we include a variable for settler colonies ('Settler colony') and one for peasant export colonies ('Peasant export colony') separately. The results show that shorter heights characterized both types of colonies. It is astonishing that the peasant export colony also had a large negative coefficient relative to the

[23] We thank Baten, Cappelli and Danubio for this information based on an ongoing project about height trends in North-east Africa. The data is not yet included in the dataset used in this study, as this project is still ongoing. If it were to be included, it would strengthen our results.

[24] For example, South Africa, Algeria and Angola were colonized quite early, and the colonized territory expanded gradually. For Zimbabwe, no height estimate for the precolonial period is available.

constant, which refers to the non-colonies. This observation also holds for the early period before the 1920s (see Column 3), and consequently for a smaller number of cases.

Although the large and negative coefficient for peasant colonies may be somewhat unexpected—owing to the higher participation of African smallholders in agricultural production and their larger share of land relative to that of African farmers in settler colonies—this result might bear some similarities to processes occurring elsewhere. Although the context was drastically different, Craig (2016, p. 17, see also Coclanis and Komlos, 1995; Komlos et al., 1995) observes that, in line with our evidence, independent farmers in North America experienced the largest decline in height. Similar to the African decline, this also took place in the context of the market integration of previously more subsistence-oriented agricultural economies: before the mid-19th century, North American farmers provided a very protein-rich diet to their children. During and after the market integration process, however, their households consumed a higher share of other products (e.g. clothes, etc.) that were available on the local markets. Given the present status of our knowledge, we can only speculate whether African independent farmers behaved similarly to North American farmers. Nevertheless, it does not seem unlikely, as additional evidence on African farmers is not available.

6. Event study

One additional test that we perform on the question of whether colonialism influenced the biological standard of living is to implement a version of an event study. The idea is to compare the decades just before and after the colonialization event. We will then check whether the heights belonging to the birth decade before colonialization were substantially different from those belonging to the decade after colonialization in the same country. The idea of an event study is that, usually, most of the other relevant variables do not change drastically within the same narrow time window.

To check the robustness of this analysis, we also look at only the three and two decades before and after colonization. Although sometimes there are missing data, we can identify the decades before and after colonialization for many individual countries. We run a regression of height on the colony variable after restricting the sample to this set of countries, and we weight the observations with population size in 1950 and calculate robust standard errors.

We display the results in Table 7. In the first column, we regress height on colonialization for the three decades before and after the colonialization event (including time fixed effects). We see that being a colony has a negative impact of 2.37 cm, which is statistically significant. The number of cases is 60. In the same specification, we consider only the two decades before and after the colonialization event, which reduces the sample size to 47, and the result is robust. Finally, we reduce the window further to only one decade before and after colonization. Again, the effect is significant even though we are down to 31 observations. In summary, this event study analysis confirms the colonial influence that we discussed above.

7. Effects of colonization on infant mortality

Finally, we assess whether colonization might have had effects on another health indicator, namely, infant mortality. Infant mortality is an alternative welfare indicator. The colonial age saw a sharp increase in trade, and this might also have worsened the disease environment. The probability of infections might have grown, as the exchange of both goods and migrants provided opportunities for germs to travel. Moreover, infant mortality is sensitive to the quality of nutrition. Strong malnutrition increases infant mortality (Baten and Blum, 2014).

We find that colonialism had a significant effect on infant mortality (Table 8). Admittedly, some of the effects might be timing effects, but even when controlling for time fixed effects, we obtain statistical significance.

8. Discussion and Conclusion

Assessing the long-run economic development of Africa quantitatively is one of the greatest challenges of our time. The number of quantitative sources on economic development is small, and the measurement quality even for the period after WWII is not always high. Stimulating African economic development is one of the most crucial issues for economics today, and the study of long-run relationships—in particular, the assessment of the influence of colonialism—can contribute to the understanding of long-term processes in Africa and other world regions. This anthropometric analysis offers essential evidence on this situation because data on human height are more readily available in the African context than other sources of evidence, such as income data (although height data is not without challenges, of course).

Using this new evidence on anthropometric development, we find that colonized Africans were shorter by at least 1.1 cm, even after controlling for a number of different variables. Second, we studied the various types of colonialism and their different potential effects on human stature. We found that both settler and peasant export colonies had an adverse impact on native African heights during the period of colonialization.

In this section, we discuss whether this substantial height decline is plausible based on what we know about health, forced labour, and conflict development. Many diseases, such as malaria and sleeping sickness, affected different African regions. The increase in forced labour, especially during the early decades of colonialism, implied that parents could not take as much care of the medical and hygienic situation of their children as before, as they had to spend many of their days building railway lines, roads and other forced labour projects (van Waijenburg, 2018). Hence, improvement in the medical situation did not progress during the first decades of colonialism; it might instead have deteriorated as we see in the description of Sierra Leone (Cole, 2015). This is also visible in the low population growth rates of the time

(Frankema and Jerven, 2014, see Appendix D). If population growth reflects health, this would imply that the medical campaigns were slightly more successful from the 1930s onwards, and especially after the 1960s. In the early decades of colonialism, in contrast, additional trade contacts resulted in additional infectious diseases (Steyn, 2003). Moreover, there was a severe pandemic among cattle, which was introduced into East and South Africa and partially into West Africa during the 1890s.

In general, very little is known about changes in health between the pre-colonial and the colonial periods. One of the exceptions is the 'preliminary' study by Steyn (2003). Based on skeletons from the northern parts of South Africa, he assessed health from the period before 1830, when this region was de facto colonized by settlers, and the post-1830 colonial period. Steyn emphasizes that the number of skeletons is small (only 31 individuals for the 'Late Iron Age' period before 1830 and 74 individuals for the post-1830 period). He finds that evidence on pre-colonial and colonial age distributions shows that health, at least, did not improve during the later period. The malnutrition signals on the skeletons also indicate worsening health during colonial times: the cribra orbitalia indicator—a bone defect in the skull above the eyes mostly caused by severe malnutrition—also suggests that health declined in the post-1830 colonial period, although the sample size and age structure is problematic for this analysis. Finally, Steyn notes the occurrence of new diseases such as tuberculosis during the post-1830 period and an increase in chronic diseases during later periods. Taking all this evidence together, there seems at the least to be no improvement in health during the colonial period after 1830 (Steyn, 2003).

The combined effects of a) new trade contacts spreading infectious disease, b) forced labour, c) conflicts, and d) a public health system that lacked investment and knowledge about the specific health environment of the African world region resulted in low health standards during the early decades of the colonial period (Patterson and Pyle, 1983). This is also clear in the higher influenza mortality rate in Sub-Saharan Africa relative to most other world regions

(Barro et al., 2020). Unfortunately, the available evidence on influenza pandemic death rates in 1918-19 is too unsystematic to include as an explanatory variable in our regressions. Moreover, the exogeneity of this measure would not be clear, as the epidemic disease caused lower heights, but a worse nutritional status (reflected in heights) also results in an increased vulnerability to infectious disease (Komlos, 1985).

Does this study have implications for today? Recently, the debate about economic development in a situation with one powerful country that strongly influences the economy of other countries has gained attention. For example, China and the Gulf States started to buy large areas of land in African and Asian countries during recent decades. China has gained influence via its ‘Belt and Road Initiative’ as well, which does not aim at colonial relationships but might result in a very asymmetric power relationship. On the other hand, these specific power asymmetries are sometimes legitimized by higher productivity and infrastructure investment (European colonialism used similar arguments), and it is interesting to compare the advantages and disadvantages of this system with those of the European colonial period.

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Appendix A

A.1. Number of cases by colonial status

Table A.1: Number of cases by colonial status, half-century, and country (Africa, 1810-1970s).

		Independent countries				Colonized countries			
Country	**Total N**	**1800**	**1850**	**1900**	**1950**	**1800**	**1850**	**1900**	**1950**
Algeria	3							3	
Angola	7					1	2	4	
Benin	7	1			1			3	2
Botswana	1							1	
Burkina Faso	14	4	1		1		1	5	2
Burundi	2							2	
Cameroon	182	1	1		172		2	4	2
Central African Republic	177		1		170			4	2
Chad	9		3		1			3	2
Congo	9	1	2		1			3	2
Congo, DRC	172	1	1		1		2	165	2
Cote d'Ivoire	11	1			1		2	5	2
Egypt	11		3	1	3		1	3	
Equatorial Guinea	1							1	
Eritrea	3		2					1	
Ethiopia	8		2	3	3				
Gabon	6	1			1			2	2
Ghana	11				2	1	2	5	1

Guinea	8				2		1	4	1
Guinea-Bissau	8	1					1	5	1
Kenya	6		1		1			2	2
Lesotho	4				1			1	2
Liberia	5			2	3				
Libya	2		1					1	
Madagascar	7		1		1			3	2
Malawi	7		1		1			3	2
Mali	10		1		1		1	5	2
Mauritania	4							4	
Morocco	5		1		2			1	1
Mozambique	9					1	1	4	3
Namibia	6							3	3
Niger	9		1	2	1			3	2
Nigeria	10	2			1		1	4	2
Rwanda	6				1			3	2
Senegal	9				1	1	1	4	2
Sierra Leone	6					2	1	3	
Somalia	6		1				1	4	
South Africa	6			3	3				
Sudan	7		3					4	
Swaziland	4				1			1	2
Tanzania	10		2		1		1	4	2
The Gambia	1							1	
Togo	6		1		1			2	2
Tunisia	1							1	
Uganda	9		2		1		1	3	2
Zambia	4				1			1	2
Zimbabwe	4							1	3
Sum	311	13	32	11	41	6	22	127	59

Notes: Calculated based on the data collection by Baten and Blum (2014). Colony definition: Olson (2013). The number of cases refers to country-birth decade units. The year in the column headers indicates the first year of a 50-year period, 1800 for 1800-1849, etc.

A.2 Sources of height values

Algeria

Chamla (1972);

Angola

Austin, Baten, van Leeuwen (2012); Eltis (1982); Hiernaux (1968); Stolz (2008);

Benin

Austin, Baten, Moradi (2007); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Pales (1953); Trevor (1947);

Botswana

Oschinsky (1954)

Burkina Faso

Austin, Baten, van Leeuwen (2012); ICF. Demographic and Health Surveys; Hiernaux (1968); Huizinga (1968); Ruelle (1904); Seric (2007);

Burundi

Hiernaux (1968); Seric (2007);

Cameroon

ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Huizinga (1968); Austin, Baten, Moradi (2007); Pales (1953);

Central African Republic

Chabeuf (1959); ICF. Demographic and Health Surveys; Hiernaux (1968); Oschinsky (1954);

Chad

Gaillard, Poutrin (1914); ICF. Demographic and Health Surveys; Hiernaux (1968); Pales (1953); Seric (2007);

Comoros

ICF. Demographic and Health Surveys;

Congo

Austin, Baten, Moradi (2007); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Seric (2007);

Congo, DRC.

Austin, Baten, Moradi (2007); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968);

Cote d'Ivoire

Austin, Baten, Moradi (2007); Cogneau, Rouanet (2009); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Pales (1953);

Egypt

ICF. Demographic and Health Surveys; Field (1952); Hiernaux (1968); Stegl, Baten (2009); Strouhal (1980);

Equatorial Guinea

Hiernaux (1968);

Eritrea

Hiernaux (1968); Oschinsky (1954);

Ethiopia

ICF. Demographic and Health Surveys; Harrison (1969); Hiernaux (1968); Oschinsky (1954);

Gabon

Austin, Baten, Moradi (2007); Chabeuf (1959); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968);

Gambia

Johnson (1970);

Ghana

Austin, Baten, Moradi (2007); Austin, Baten, van Leeuwen (2012); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Cogneau, Rouanet (2009);

Guinea

De Lestrange (1950); ICF. Demographic and Health Surveys; Hiernaux (1968); Pales (1953);

Guinea-Bissau

Austin, Baten, Moradi (2007); Eltis (1982); Hiernaux (1968); Pales (1953); Stolz (2008);

Kenya

ICF. Demographic and Health Surveys; Hiernaux (1968); Orr, Gilks (1931); Seric (2007);

Lesotho

ICF. Demographic and Health Surveys; Hiernaux (1968);

Liberia

ICF. Demographic and Health Surveys; Hiernaux (1968);

Libya

Sabatini (1936);

Madagascar

Chabeuf (1969); ICF. Demographic and Health Surveys; Oschinsky (1954)

Malawi

ICF. Demographic and Health Surveys; Laing (1964); Maynard, Turner (1914); Nurse (1969);

Mali

ICF. Demographic and Health Surveys; Hiernaux (1968); Huizinga, Birnie-Teller (1966); Lobsiger-Dellenbach (1951); Pales (1953); Prazuck, Fisch, Pichard, Sidibe (1901);

Mauritania

Hiernaux (1968); Pales (1953);

Morocco

Coon (1931); ICF. Demographic and Health Surveys;

Mozambique

Austin, Baten, Moradi (2007); ICF. Demographic and Health Surveys; Eveleth, Tanner (1990); Eltis (1982); Hiernaux (1968); Laing (1964); Maynard, Turner (1914); Pales (1953); Oschinsky (1954);

Namibia

ICF. Demographic and Health Surveys; Hiernaux (1968); Oschinsky (1954);

Niger

ICF. Demographic and Health Surveys; Hiernaux (1968); Lobsiger-Dellenbach (1951); Pales (1953);

Nigeria

Austin, Baten, Moradi (2007); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Johnson (1970); Talbot, Mulhall (1962);

Rwanda

ICF. Demographic and Health Surveys; Eveleth, Tanner (1990); Hiernaux (1968); Oschinsky (1954);

Senegal

Austin, Baten, Moradi (2007); ICF. Demographic and Health Surveys; Eltis (1982); Hiernaux (1968); Pales (1953);

Sierra Leone

Austin, Baten, Moradi (2007); Voyages Database, 2016; Hiernaux (1968); Pales (1953);

Somalia

Hiernaux (1968); Oschinsky (1954); Puccioni (1931); Seric (2007);

South Africa

Crayen (2006); Hiernaux (1968); Laing (1964);

Sudan

Hiernaux (1968); Oschinsky (1954); Pales (1953); Roberts (1954); Sukkar (1976);

Eswatini (formerly Swaziland)

ICF. Demographic and Health Surveys;

Tanzania

ICF. Demographic and Health Surveys; Hiernaux (1968); Juergens (1967); Oschinsky (1954);

Togo

ICF. Demographic and Health Surveys; Pales (1953);

Tunisia

Oschinsky (1954);

Uganda

ICF. Demographic and Health Surveys; Eveleth, Tanner (1990); Hiernaux (1968); Oschinsky (1954);

Zambia

ICF. Demographic and Health Surveys;

Zimbabwe

ICF. Demographic and Health Surveys; Oschinsky (1954); Stayt (1931)

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Appendix B

B.1 The effect of lagged colonialism on height

In the regression studies above, we found that contemporaneous colonialism led to decreasing height. It would be interesting to see whether lower height is also predicted if we lag colonialism. This would indicate that it is instead a continuous process of height decline that was initiated by the establishment of colonialism. We find that, in reality, the introduction of colonialism was not a one decade to the next event, that is, that height would drop in the decade of its introduction and stay at the lower level until colonialism was overcome later. Rather, it was a process that started at a certain point but then developed over several decades. In Table B1, we performed a t-1 test and find that the effect is undoubtedly weaker and insignificant if we move the explanatory variable colonialism back by one decade.

Table B.1

Effect of lagged colonialism on height

	(1)
Colony lagged	-.8942959
	(0.301)
Cattle per capita (log)	-.0409413
	(0.941)
Time F-effects	Y
Country F-effects	Y
Constant	168.3203
	(0.000)
Observations	193
R-squared	0.8101

Notes: We lag the explanatory variable colony by one decade and run a regression of height on the lagged colony variable and the logarithmized cattle variable. Thereby, we include time fixed effects and country fixed effects.

Appendix C

C.1 Histograms of anthropological surveys: the examples of Kenya and Sudan

Fig. C.1.1. Kenya

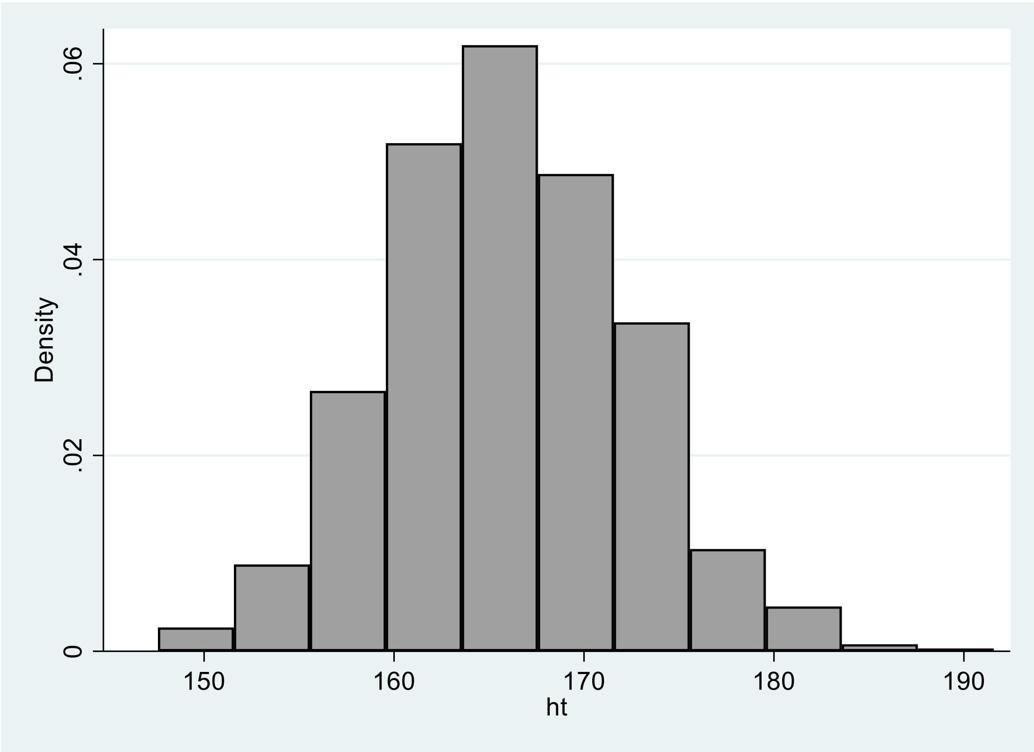
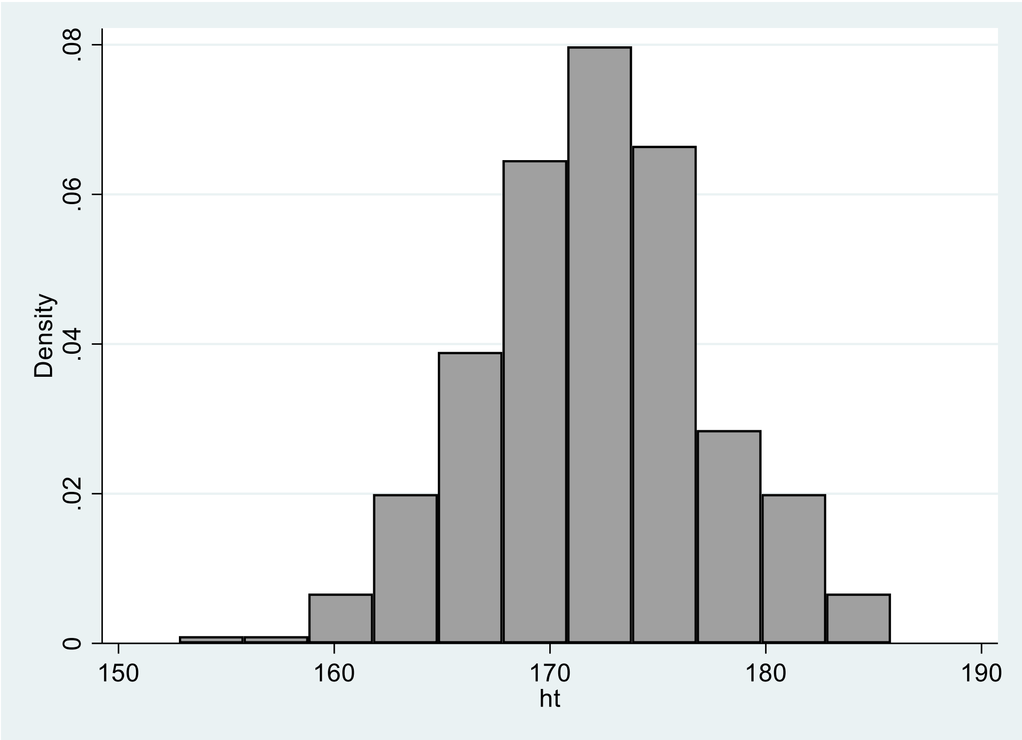


Fig. C.1.2. Sudan



Sources: see Appendix A.

Appendix D

D.1. Population growth in colonial Africa

Could a strong population growth have resulted in height decline? Unfortunately, most research on early African population trends needs to rely on weak estimates since the data for the period before and during colonial times is either very thin or completely unavailable. Of course, the availability of data depends on the specific region and period analyzed. For instance, concerning specific regions during pre-colonial times, the works of Thornton (1977) for the kingdom of Congo and the work of Nouschi (1961) for Algeria are extremely insightful. However, when it comes to general growth trends for each country, it is often necessary to rely on estimates that are continuously being improved. We pasted below the most recent population estimates (in levels and growth) at an aggregate level for all of Africa. Frankema and Jerven (2014) – mostly building on Manning's (2010) work - provide the most recent estimates for all Africa.

Interestingly, population growth remained very slow until the 1930s, then increased slightly, and became fast not before the 1960s, when new medical approaches were used to improve population health. Hence, this would be consistent with the hypothesis that there was not a dramatic change of nutrition- or health-induced population growth between pre-colonial- and early colonial times.

Frankema and Jerven also review the availability of population data and summarize the status of research concerning the debates on population estimates. Overall, the evidence seems to indicate that it was unlikely that many regions in Africa, which was a continent of a very thin population as Austin describes in detail, were experiencing, for example, a Malthusian population growth trap, which reduced height during colonialism. In particular, for instance, according to Austen (1987, p. 146), population pressure was not strong during the colonial period in Western'‘s Africa 'étatist peasant regimes' and, until the 1920s, the population probably declined, because of slave trades, military campaigns, forced labour, diseases, famines, etc.

Table D.1.

Some evidence from Frankema and Jerven (2014, Table 10, p. 925-926)

Estimated total African population growth and levels, 1851-1960

	Manning		FrankemaJerven		
	Levels	Decadal growth	Levels	Decadal growth	Adjusted 1950 level
1850	139.6		114.1		122.7
1860	139.8	0	117.7	0.3	126.5
1870	143.4	0.3	122.1	0.4	11.3
1880	145.7	0.2	127.7	0.4	137.3
1890	148.2	0.2	134.4	0.5	144.5
1900	151.2	0.2	137.1	0.2	147.4
1910	157.8	0.4	141.9	0.3	152.6
1920	163.0	0.3	147.3	0.4	158.5
1930	180.0	1	166.4	1.2	179.3
1940	194.7	0.8	188.7	1.3	203.6
1950	220.3	1.2	221.8	1.6	240
1960	277.9	2.4	279.2	2.3	

Sources: See fig. 2a in Frankema and Jerven (2014).

Appendix E

Comparison of liberated slaves in Sierra Leone and slaves in Havana, as well as comparison of slaves born in Africa and slaves born in the New World

We compared the heights of exported slaves in Eltis' database: We also counter-checked the Sierra Leone data with a slightly smaller, but still substantial dataset on slaves measured in Havana, when they were sold to Cuban buyers. The correlation using country-and-birth-decade units between the 1780s and the 1820s is as high as 0.75 ($p = 0.001$). The overlapping units represented completely different sets of persons. Probably nobody measured in Sierra Leone was again measured on Havana or vice versa. Hence the high correlation between these completely different institutional contexts of measurement suggests that the correlation is driven by the factors in their respective country and birth decade rather than by selectivities caused by the source or the recording process.

Moreover, we also compared the slave heights in the Americas in the 18th and 19th centuries comparing slaves who were born in Africa and slaves born in the Americas. This clearly identified the impact of the new world. We based this discussion on the work by Baten et al. (2009) who compared black people born in Africa with those born in Brazil. The former were much shorter than those born in Brazil (their Table 3, Col. 6). Black people born in Africa were 161.7 cm (N=151), while Brazil-born were significantly taller, at 164.9 cm (N=921, Baten et al. (2009)). Moreover, this is consistent with Eltis, as Angola and Congo had relatively low heights (many slaves, who were transported to Brazil, were coming from Angola and Congo).

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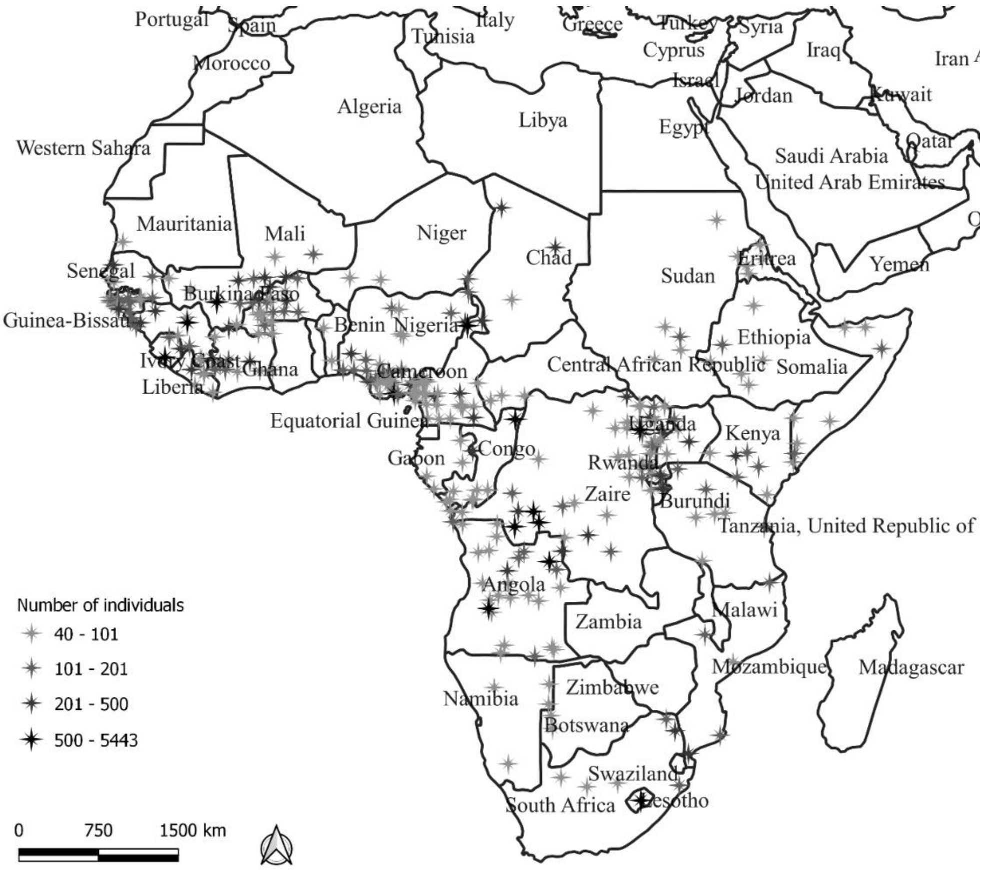
Figure 1

Number of observations in Hiernaux (1968)

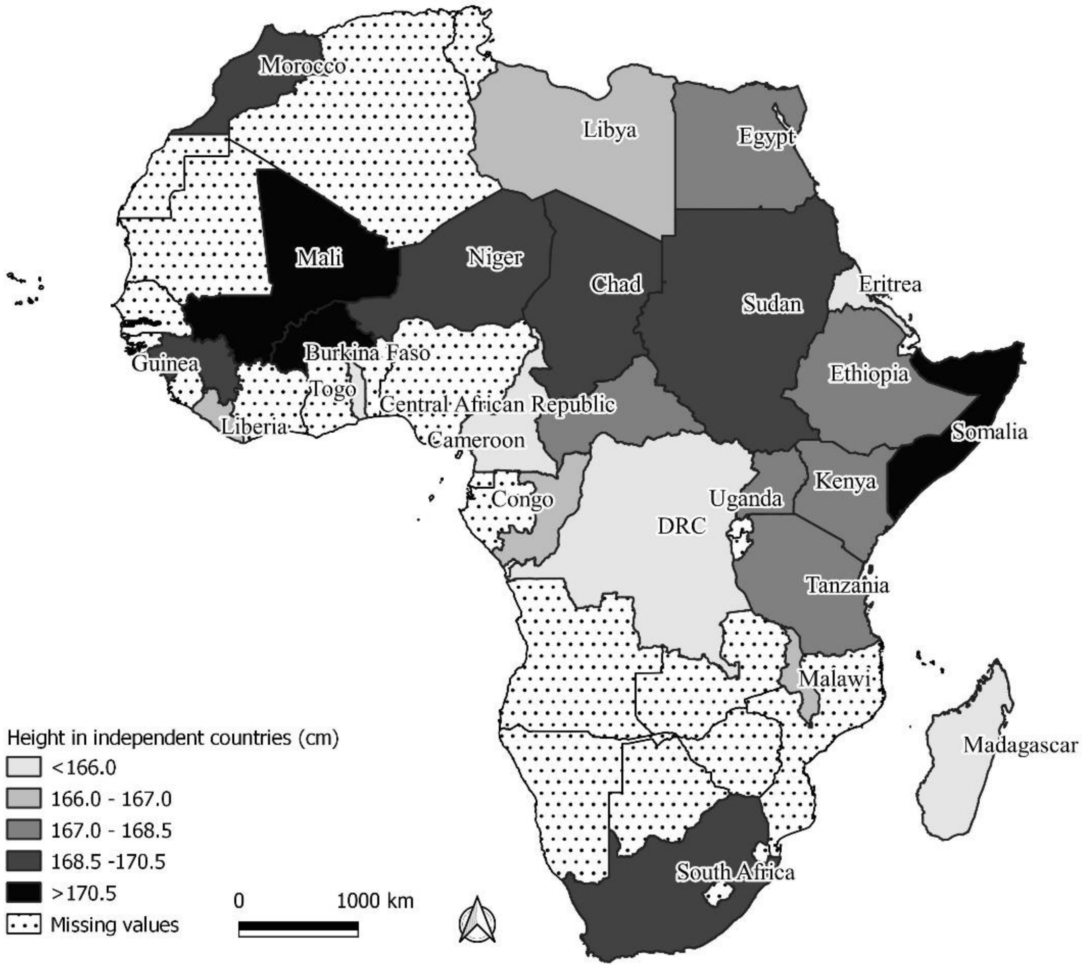


Source: Hiernaux (1968).

Notes: This map displays the information provided by one of the major sources used in our study, Hiernaux (1968). The map shows the number of individuals. We only include those based on Hiernaux because he reported coordinates which most of the other studies did not. 312 of Hiernaux's observations provide information on the average stature. We could not include all his observations as some could not be assigned to specific birth decades. Concerning the precision of the coordinates of each observation, Hiernaux did not report decimals in coordinates and, thus, when georeferencing, the dots were not exact. Therefore, we georeferenced each dot, based on the map presented in Hiernaux (1968) and the information provided by Murdock about the location of ethnic groups.

Figure 2

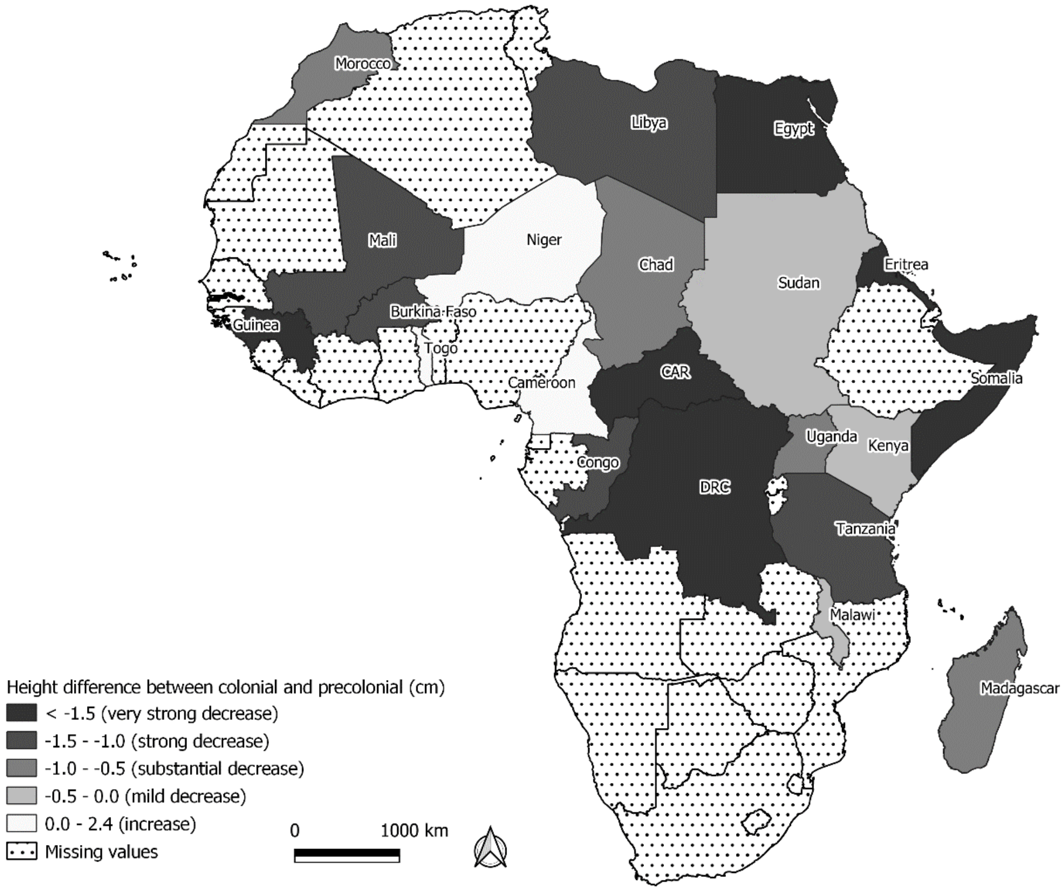
Heights in independent countries, 1850-1949



Source: see Appendix A.

Figure 3

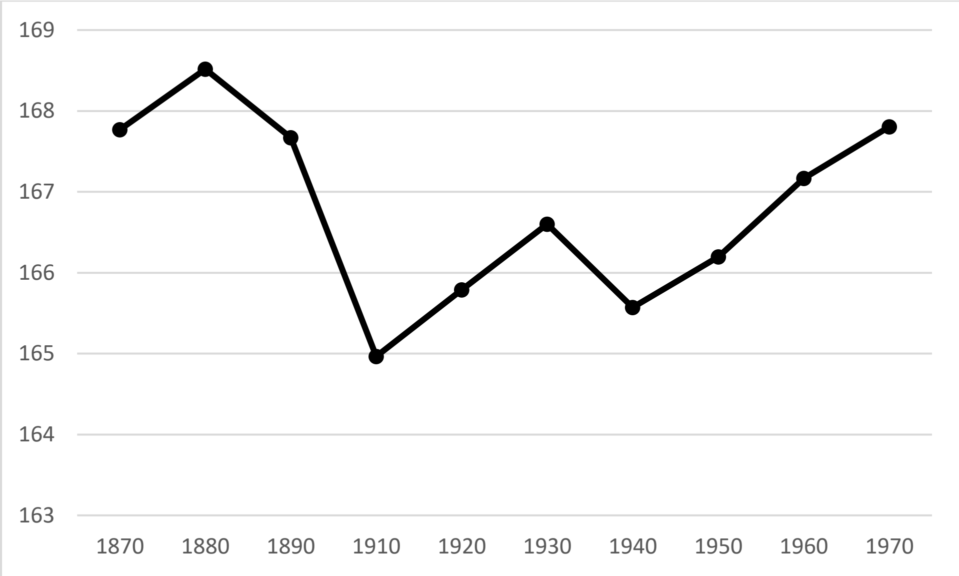
Differences in heights between precolonial and colonial birth decades, 1850-1949



Source: see Appendix A.

Figure 4

Height trend in Tanzania, 1870s-1970s



Source: see Appendix A.

Table 1
Number of individuals surveyed per observation for each birth decade and country.

Country	Birth decade																
	1810	1820	1830	1840	1850	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	All
Angola	158+							319	41	162	123	107	124					1034
Burkina Faso	1231	169	432	246			326		131	167	1902	106	107	165	1247	2895	3739	12863
Burundi												216	335					551
Benin	475										93	240	81		627	3197	5641	10354
Botswana											43+							43
Congo, DRC	166						1010	52	88		4000	214	214		134	843	1307	8028
Central African Republic								41		60	98	209	79		359	1031	644	2521
Congo	143				30	30						100	101	214	340	1332	2182	4472
Cote d'Ivoire	80				50+				208	68	1324	330	455	71	933	2342	1903	7787
Cameroon	51						230	100	100	100	352	67	104		655	1960	2718	6449
Algeria											104	157	160					421
Egypt					738	125	473	75		936	205	103		195	430	4749	5385	13414
Eritrea						35		54					51					140
Ethiopia						46		49				51	81-	1721-	287	1246	2002	5483
Gabon	166										57	99			750	1491	2065	4628
Ghana	125+							232+	1841	1588	1736	1736	530	1749	52	942	1323	11877
The Gambia												135						135
Guinea									48	100	198	198	230		265	892	1243	3178
Equatorial Guinea													30					30
Guinea-Bissau	53								46	116	1106	50	249	380	152			2152
Kenya								128		865		147			613	1638	2553	6091

Liberia												265	410		271	1386	2012	4353
Lesotho										521					300	713	911	2445
Libya									126			303						429
Morocco								529						217	1580	3941	4900	11167
Madagascar						76				79	66	493			677	1805	2543	5739
Mali								154	39	33	3030	101	116	400	521	2885	4170	11449
Mauritania										129	111	100	53					393
Malawi							95					242	10000	174	740	1970	3472	16693
Mozambique	46						883			52	120	341	99		1091	2596	3747	8975
Namibia										75			54	151	243	1837	2773	5133
Niger								132		106	143-	143	42	140	130	922	1403	3186
Nigeria	1906	4928					127+				100	79	340	33	675	1553	2386	12127
Rwanda											110	254	184		356	1080	1603	3587
Sudan							64	100	39-	141	39	107	359					849
Sierra Leone	197+	40+							700		217	30	700					1884
Senegal	464+								51		198	121	160	128	241	851	1287	3503
Somalia								35-	52	295	42	124	47					595
Eswatini (f.Swaziland)													851		105	582	899	2437
Chad							290	105	187	232+		443	443		594	2369	3389	8052
Togo						43				100		71			1146	3041+	4064	8465
Tunisia											30							30
Tanzania							396	105	289		114	114	129	309	534	1961	3241	7192
Uganda							169	152	223		424	548	74		97	515	886	3088
South Africa												230-	473-	290	1971	2617	3277	8858
Zambia														182	176	1118	2020	3496
Zimbabwe										168					334	1433	2357	4292
Sum	5261	5137	432	246	818	390	4117	2362	4209	6093	16241	8374	17465	6519	18626	59733	84045	240068

Source: see Appendix A.

Note: The grey areas are classified as colony according to Henderson and Whatley (2014). We only included the observations that represented averages of 30 or more individuals. The symbol '+' indicates that Olsson (2013) defines this case as colony, while Henderson and Whatley do not. The symbol '-' indicates the opposite disagreement.

Table 2
Height by colonial status, half-century, and country (Africa, 1810-1970s).

	Independent countries				Colonized countries			
Country	**1800**	**1850**	**1900**	**1950**	**1800**	**1850**	**1900**	**1950**
Algeria							168.0	
Angola					160.5	169.0	167.1	
Benin	164.9			170.3			168.4	170.3
Botswana							165.4	
Burkina Faso	165.2	171.2		172.8		167.9	171.6	172.5
Burundi							167.7	
Cameroon	165.9	165.7		171.6		165.3	167.9	171.4
Central African Republic		167.1		169.9			164.9	170.1
Chad		169.5		173.8			168.6	174.0
Congo	163.3	166.8		169.0			165.6	168.9
Congo, DRC	163.3	165.7		169.0		162.9	165.3	168.4
Cote d'Ivoire	165.1			171.2		169.7	167.5	170.7
Egypt		167.0	167.5	170.7		163.0	165.8	
Equatorial Guinea							169.0	
Eritrea		165.8					164.0	
Ethiopia		168.4	167.5	167.3				
Gabon	165.4			170.5			164.6	171.0
Ghana				169.8	164.1	166.0	167.3	169.5
Guinea				169.7		164.2	168.2	168.7
Guinea-Bissau	165.4					168.3	168.0	168.9
Kenya		167.9		170.9			167.1	170.3
Lesotho				168.5			168.0	168.1
Liberia			167.4	168.0				
Libya		166.5					165.1	
Madagascar		163.9		163.9			163.3	164.5
Malawi		166.7		166.7			166.7	166.9
Mali		171.0		172.5		169.4	169.9	172.6
Mauritania							169.4	
Morocco		168.6		170.1			168.1	169.0
Mozambique					164.1	167.1	168.1	165.9
Namibia							170.0	172.1
Niger		173.0	170.1	171.3			171.8	171.2
Nigeria	163.7			169.7		165.6	166.1	169.2
Rwanda				167.9			171.0	168.8
Senegal				174.7	165.4	171.8	170.9	174.0
Sierra Leone					163.4	165.5	166.1	
Somalia		172.8				171.4	171.1	
South Africa			169.1	169.5				
Sudan		169.2					168.9	
Swaziland				170.5			168.8	169.7
Tanzania		168.1		167.8		167.7	165.7	166.7
The Gambia							166.6	

Togo		165.3		170.5			167.7	170.7
Tunisia							162.9	
Uganda		167.2		169.6		166.4	166.1	170.0
Zambia				168.9			168.1	169.7
Zimbabwe							167.6	171.1
Total	164.7	168.0	168.3	169.9	163.5	167.1	167.5	169.8

Sources: see Appendix A.
Notes: Colony definition: Olsson (2013). The height values refer to country-half century units, independent vs. colonized. The year in the column headers indicates the first year of a 50-year period, 1800 for 1800-1849, etc. The overall arithmetic average of all independent countries 167.7, while that of the colonized countries is 166.9.

Table 3
Descriptives

Variable	Obs	Mean	Std. Dev.	Min	Max
Birth decade	311	1919	40	1810	1970
Height	311	168.22	2.62	160.50	174.74
Colony	311	0.69	0.46	0	1
Colony peasant	311	0.61	0.49	0	1
Colony settler	311	0.16	0.36	0	1
Cattle (ln)	293	-1.62	1.35	-5.93	1.17
Infant mortality (ln)	86	4.84	0.46	3.17	5.66

Sources of height: see Appendix A. Sources of colony: Henderson and Whatley (2014); Olsson (2009). Some colonies had both peasant and settler colony aspects. Sources of cattle and infant mortality: clio-infra.eu
Notes: Mean: unweighted averages.

Table 4
Fixed Effects Regressions: Determinants of Height in Africa, 1810-1970s

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period/ Source excluded	N	N	N	Slave	≥1920	N	≥1920
Colony	-1.08***	-1.23***		-1.08***	-1.69***		
	(0.000)	(0.000)		(0.004)	(0.007)		
Cattle p.c.		0.46	0.29	0.46	-0.33	0.32	-1.69
		(0.121)	(0.409)	(0.135)	(0.766)	(0.384)	(0.229)
Colony incl. first dec.			-1.61***				
			(0.000)				
Colony (Henderson/Wh.)						-1.13*	-1.91**
						(0.051)	(0.017)
Constant	164.82***	165.92***	165.61***	163.15***	164.09***	165.49***	160.95***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	299	282	293	268	104	293	114
R-squared	0.63	0.68	0.67	0.62	0.68	0.64	0.58
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
r2_w	0.634	0.685	0.669	0.618	0.676	0.643	0.583
r2_o	0.262	0.336	0.306	0.238	0.174	0.307	0.00542
r2_b	0.0620	0.115	0.108	0.0705	0.00718	0.0923	0.0732
r2_a	0.612	0.663	0.647	0.591	0.633	0.620	0.533
N_clust	47	45	45	45	37	45	37

Notes: Heteroscedasticity-robust p-values in parentheses. ***, **, * denote 1, 5, 10% level of significance. Clustered at the country level. Time-fixed effects: birth-decade dummy variables. WLS regressions, weighted with population of country in 1950. Due to country fixed effects estimation, we lose some observations. Height is regressed on a time-variant variable that measures colonization ('Colony', 'Colony (incl. first dec.)', and 'Colony (Henderson/Wh)', alternatively). Col. (1) shows an estimation of a simple country fixed-effects model with only the variable 'Colony' and time fixed effects. Col. (2) adds a control for the number of cattle per capita. Col. (3) includes, different to the previous specifications, also the first decade of colonization. Col. (4) excludes the source 'slaves/liberated Africans'. Col. (5) and (7) exclude all birth decades including and after the 1920s. Henderson and Whatley's (2014) classification of colonization ('Colony (H&W)') is used in Col. (6) and (7) as a robustness check of the 'colony' variable.

Table 5
Regressions: Assessing different weighting possibilities

	(1)	(2)	(3)	(4)
Colony	-1.83***	-1.06*	-1.07**	-1.17**
	(0.000)	(0.066)	(0.040)	(0.025)
Constant	165.77***	165.11***	164.93***	165.19***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	196	196	196	196
R-squared	0.79	0.88	0.80	0.79
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Rsq adj.	0.700	0.827	0.722	0.696
Number of countries	44	44	44	44

Notes: Heteroscedasticity-robust p-values in parentheses. ***, **, * denote 1, 5, 10% level of significance. Clustered at the country level. We estimate a least square dummy variable (LSDV) model with height as dependent variable. As in Table 4, height is then regressed on a time-variant colonization variable, using the period 1810s-1940s. This time, different variables are used as weights. Time-fixed effects: birth-decade dummy variables. Col (1) is same specification as Col. (1) in Table 4, but for the period until the 1940s (including this decade); that is, weighted with population size in 1950. Col. (2) is the same specification but weighted with the number of underlying individuals counted per observation. Col. (3) is also the same but weighted with the square root of the number of observations and Col. (4) is unweighted.

Table 6
Fixed-Effects Regressions: Settler and peasant export colonies, precolonial centralization, and heights in Africa, 1810-1970s

	(1)	(2)
Peasant export colony	-1.24***	-1.71***
	(0.000)	(0.009)
Settler colony	-1.20**	-1.56**
	(0.019)	(0.016)
Cattle p.c.	0.46	-0.38
	(0.150)	(0.745)
Constant	165.91***	163.97***
	(0.000)	(0.000)
Observations	282	104
R-squared	0.68	0.68
Number of countries	45	37
Country FE	YES	YES
Time FE	YES	YES
r2_w	0.685	0.676
r2_o	0.335	0.164
r2_b	0.115	0.00414
r2_adj.	0.662	0.629

Notes: Heteroscedasticity-robust p-values in parentheses. ***, **, * denote 1, 5, 10% level of significance. Clustered at the country level. Time fixed effects: birth decade dummy variables. WLS regressions, weighted with population of country in 1950. Settler colonies: Algeria, Angola, Eritrea, Kenya, Mozambique, Namibia, South Africa, Tanzania, Tunisia, Zimbabwe, Malawi, and Zambia. Peasant colonies are all others, except Ethiopia and Liberia. The constant refers to these colonies?, plus all not-yet or not-any-more colonized countries. Column (2) excludes all birth decades including and after the 1920s.

Table 7
Height event analysis: Before and after the "Event" Colonialization in Africa, 1810s-1970s

	(1)	(2)	(3)
Decades before and after:	3+3	2+2	1+1
Colony	-2.37***	-2.41***	-2.25***
	(0.001)	(0.001)	(0.002)
Constant	171.55***	171.36***	171.68***
	(0.000)	(0.000)	(0.000)
Time fixed effects	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Observations	59	46	31
R-squared	0.82	0.85	0.91

Notes: Heteroskedasticity-robust p-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time fixed effects based on half centuries. Three regressions of height on the colony variable and country fixed effects. We restricted the sample to the set of countries for which height data are available for the three decades before and after the colonization event (Col. 1). Col. (2) repeats the analysis with only two decades before and after colonization, and finally Col. (3) with only one decade before and after colonization. Reducing the decades comes along with reducing the sample size. The analysis is weighted with the population size in 1950.

Table 8

Regressions: Determinants of Infant Mortality (in logs) in Africa

	(1)	(2)
Colony	0.23**	
	(0.013)	
Settler colony		0.15*
		(0.083)
Peasant colony		0.23**
		(0.028)
Constant	4.71***	4.71***
	(0.000)	(0.000)
Observations	87	87
R-sq. (adj.)	0.169	0.151

Notes: Heteroskedasticity-robust p-values in parentheses. ***, **, * denote 1, 5 10% level of significance. Fixed Effects and R-sq within in Col. 1 and 2, RE, clustered at country level in Col. 3-6. WLS regressions, weighted with population of country in 1950. Col. (1) regresses infant mortality on a joint colony variable, while Col. (2) distinguishes between 'Settler colony' and 'Peasant colony'.