

Explaining Stunting in Nineteenth Century France

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Summary

We examine the share of French men with stunted growth during the nineteenth century using data on potential conscripts into the army. The share of stunted men (height below 1.62 meters) in France's 82 departments declines dramatically across the century, especially in the south and in the west. Our models examine the role of education expenditures, health care personnel, local wages, asset distribution, as well as a dummy variable for Paris as determinants of stunting, and decompose changes over time into the effects of levels and returns to covariates. All covariates are strongly significant, with education spending being particularly important. Living in congested Paris contributed to poor health status.

I. INTRODUCTION

It is now widely acknowledged that improvements in socio-economic conditions over the past couple of centuries have contributed to substantial improvements in health and nutritional status. Along with increasing longevity, perhaps the clearest manifestation of this improvement in general health and nutritional status is the dramatic increase in stature in Europe and North America, as well as other regions in the world. This includes the case of France, the subject of this paper, where increasing heights of the population during the eighteenth and nineteenth centuries have been the subject of a range of papers.¹

In this paper we examine the share of French men who exhibit stunted growth during the course of the nineteenth century, and then model the determinants of the shares of men whose stature falls below normative standards (as defined by the World Health Organization), with the unit of analysis being the 82 administrative departments into which France was then divided.² We use data collected on all men who were called up for possible conscription into the French army during the nineteenth century. The screening of all men at the age of 20 for mandatory military service involved a physical examination that included measuring their stature. This was undertaken by local officials. While individual heights were recorded at the time of conscription, the data we have available are limited to the number of men that fall into specific bins, or height intervals, for each year and department. Thus, we have virtually a complete census of the height information for each year, disaggregated by height interval and department.

While we present descriptive data on changes in the share of stunted men by year, our main purpose is to model the determinants of the share of stunted men in a department, since we do not have covariates at the level of individuals. Furthermore, it was not possible to construct a reliable data set with annual or even decade specific information on all the explanatory variables, disaggregated to the level of the department. Instead, we initially explain the share of stunted men in the last quarter of the century (1875-1900) as a function of a set of explanatory variables that are from the 1850s and early 1860s. Next we run another identical model, but this time we do so with the share of stunted conscripts from the period 1830 to 1850. In this case, the independent variables are from first half of the century. Thus, our models incorporate lags between the time of conception and early childhood from which the explanatory variables are drawn, and attained adult stature as measured when the men are being conscripted into the army. This approach allows us to largely deal with any concerns about reverse causality and endogeneity of explanatory variables.

¹ See, for example, Le Roy Ladurie's Preface to d'Angeville; Bernageau *et al.*, 'Le conscrit'; van Meerten, 'Developpement économique'; Weir, 'Parental Consumption Decisions' and 'Economic Welfare'; Komlos, 'An Anthropometric History'; and Heyberger, *La révolution des corps*.

² Here we consider the 82 departments (*départements*) which can be observed over the whole period under survey.

The model estimated for the two time periods have a common set of covariates. We thus are able to not only examine the coefficients for each period, but additionally we decompose observed changes in the share of men who are stunted in the 82 departments into changes in levels of the explanatory variables, as well as the returns to these factors.

In the remainder of the paper we begin with a more complete discussion of the methods and empirical approach we employ in Section II. This is followed in Section III with a discussion of the data. We present the results in the Section IV, followed by concluding comments and a discussion of the results.

II. METHODS and EMPIRICAL APPROACH

Since we are interested in the question of what were the levels and determinants of health and nutrition in nineteenth century France and how they evolved over the course of the century, our first task is to define poor health and nutrition. We follow what is acknowledged to be the preferred method of relying on stature, or heights standardized by age as our indicator of health. It is now well established that the best global indicator of well-being is height, standardized for age and gender³. According to World Health Organization, stunting, as discussed below in more detail, is defined as a person's height falling below a normative threshold of two standard deviations below the median of the global reference population. This is an appropriate indicator of the general health status of the population, since growth failure is "...the best general proxy for constraints to human welfare of the poorest, including dietary inadequacy, infectious diseases and other environmental health risks."⁴ Quite simply, stature captures the "...multiple dimensions of the individual health and development and their socio-economic and environmental determinants"⁵. Furthermore, adult stature not only is a good indicator of prior episodes of, and current vulnerability to, contagious and chronic disease, but has been shown to be an important determinant of the risk of mortality, even controlling for an individual's weight.⁶

In our case, we examine the heights of individuals at the time of conscription into the army at age 20. While a child's height-for-age is widely acknowledged as the best overall contemporaneous indicator of the general health status of the population, the heights of young men entering adulthood is best interpreted as a cumulative indicator of their overall health and nutritional status during their formative years, particularly the period prior to the beginning of puberty.⁷ Thus, children and adolescents who are in poor health, due to the combination of infectious disease, lack of a nutritious diet, and poor overall pre- and post-natal care, will have stunted growth and lower attained stature as they enter adulthood.

³ See de Onis, Frongillo and Blossner, 'Is malnutrition'.

⁴ Beaton *et al.*, 'Appropriate use', p. 2.

⁵ *Ibid.*

⁶ See Fogel, *Escape*.

⁷ There is some evidence that the health and nutrition during the prenatal period and the first 24 months of life will be the most important years in determining the height of an adult.

This fact has led economic historians to rely on mean heights of population groups to define their overall health and nutrition. However, we do not adopt the use of population means for two reasons. First, our data do not provide information on actual heights of individuals, but instead we know the number of individuals whose heights fall in bins defined by various intervals, e.g., 1.65 – 1.66 meters. Thus deriving a reliable measure of central tendency is a thorny undertaking. A second reason for departing from the standard practice of focusing on mean heights is that a measure of central tendency overlooks what is arguably the main consideration in defining the health status of the population – that is, the share of the population that falls before a normative standard, or cut-off point, that defines poor health. In other words, by focusing on the mean or median heights, we can not make as reliable statements about the share of the population in poor health since heights in poorly nourished populations are not necessarily normally distributed. That is, two populations, for example, could have the same mean despite having a very different share of persons who fall below the poverty line. Similarly, the distribution of anthropometric measures, such as height for age is neither normal nor constant among populations with widespread malnutrition.⁸ Instead, there is often considerable leftward skewing, as well as other differences in the higher moments of the distribution that make it problematic to rely on differences in means over time or between regions, as an indicator of the level of malnutrition in the population.⁹

Thus, our preference is to measure and explain differences in health across time and space using an appropriate threshold, conceptually equivalent to a poverty line. We still need to identify a cut-off point to distinguish the healthy from those that have suffered the ravages of poor health and undernutrition, as manifested in being stunted as they enter adulthood. Our choice of cut-off point to make this distinction relies on the norms of a healthy reference population which serves, analogous to a poverty line, to distinguish those in whose growth is stunted from the healthy population. More specifically, we follow the widely accepted convention and employ two standard deviations (or z-scores) below the median height of 20-year-old adults of the healthy reference population as our definition of poor health and malnutrition. To amplify, we define the z-score as follows:

$$z\text{-score} = \frac{x_i - x_{median}}{\sigma_x}$$

where x_i is height for adult i , x_{median} is the median height for a healthy and well-nourished 20-year-old male from the healthy reference population, and σ_x is the standard deviation from the mean of the reference population. Note that the z-score for

⁸ Anthropometric measures in healthy populations, however, seem to be distributed quite normally.

⁹ This point is illustrated well in the paper by Pradhan, Sahn and Younger (‘Decomposing’) where they decompose world health inequality relying on the distributions of child heights. Similarly, Sahn and Younger’s cross country study shows that changes in the shape of the height distribution is, in addition to mean shifts, an important determinant of inter-temporal changes in the share of the population that is stunted (‘Improvements’).

the reference population has a standard normal distribution in the limit. Thus, there is a probability distribution on the expected value of a z-score for any given adult – a standard normal distribution to be precise. In other words, there is a less than 2.3 percent probability that a healthy adult will have a height-for-age z-score of less than -2 . Based on this probability statement, the convention is that adults whose z-scores fall below -2 are classified as having stunted growth due to disease and malnutrition.¹⁰

Perhaps the more difficult issue is defining the reference population to which this cut-off point is applied. One option that we initially considered was to use the threshold chosen by the army, but there are at least two good reasons not to do that. First, the threshold chosen by the army varied throughout the century, ranging from 1.54 to 1.576 meters. Second, the army set a very low threshold, because they did not want to exclude a significant share of young men, especially in poor regions with high shares of stunted men.¹¹ Our objective, however, is not to maximize the number of potentially able recruits, but to identify the share of stunted men who presented themselves for conscription. To do so, we follow the present practice as discussed in the public health and nutrition literature and employ the healthy reference North American population, for which there are established norms and height distributions for males 240 months of age. Our use of the North American norms has its conceptual underpinning in the widely accepted practice of measuring the share of malnourished children in a population, whether in India, Brazil, Burkina Faso, Romania or Vietnam, using the same -2 z-score cut-off point relative to the same North American reference population.¹² More specifically, the seminal work of Habicht *et al.*¹³ and numerous subsequent studies have pointed out that there are no observed differences in early child height among different racial and ethnic groups. Instead, environmental influences explain the differentials in height distributions observed between population groups. Researchers in the biomedical sciences and physical anthropology have thus agreed that a common growth standard for children is appropriate world wide.¹⁴

For adults, the use of growth standards from North America is reasonable given that the racial composition of the French population of the nineteenth century is quite similar to the population of largely Caucasian males that are the basis of the WHO reference standards. We are comfortable using this group as a reasonable approximation of the potential stature that would have been achieved among a healthy population of

¹⁰ The normative cut-off point is based on a relatively straightforward and compelling statistical logic that if an individual's height falls below this level, there is a 97.7 percent probability that they are undernourished. Using a cut-off point of -1.5 SD, this drops to 93.3 percent, meaning our confidence that the individuals identified as being unhealthy drops considerably. That being said, we have conducted sensitivity analysis to the choice of cut-off point and find that this does not alter qualitatively our results. More specifically, instead of selecting 1.624 cm, which corresponds closely to the -2 SD score used by WHO (‘Measuring change in nutritional status’), we ran the models with a cut-off point of 1.65, which corresponds closely to the -1.5 SD score.

¹¹ See Woloch, *New Regime*.

¹² See WHO, ‘Measuring change’; WHO, ‘Physical Status’.

¹³ Habicht *et al.*, ‘Height’.

¹⁴ See Graitcher and Gentry, ‘Measuring children’; WHO, ‘Measuring change’; Martorell and Habicht, ‘Growth in early childhood’; Ulijaszek, ‘Ethnic differences’; Bustos *et al.*, ‘Growth’.

young men, absent of disease and malnutrition in nineteenth century France. Thus, we define the share of stunted new conscripts to be those whose heights are less than or equal to 1.6247 meters, which corresponds to -2 standard deviation scores of the WHO growth standards. And while there is little disagreement that adult stunting captures the insult from disease and inadequate diet that plagued him during childhood, it also seems clear that at least to some extent, that adult stunting is not only a manifestation of past insults, but captures permanently impaired health status of the adult as well. There is considerable evidence that stunted adults not only have shorter life-spans due to a higher risk of a range of adult onset diseases, such as cardiovascular disease,¹⁵ but they are less physically productive.¹⁶ Thus, we can say with a high degree of certainty that the share of the 20-year-old population that is stunted at the time of conscription, is a reflection of the overall health of the cohort at present, although, short stature captures the consequences of infection and malnutrition, particularly during the pre-natal period and early childhood.

Given that our data do not provide individual measures of heights, we have to select a cut-off between the bins into which the individual observations are sorted. In the period from 1820 through 1872, the closest threshold in the bin data is 1.624 (below 5 French feet¹⁷), almost an exact correspondence to -2 z-scores of our reference standard. However, the army changed very slightly the intervals into which heights were characterized in the last quarter of the century. Thus, for the period 1875 to 1900, we raise the bin ceiling to 1.629 meters.

We then proceed to model the share of stunted men, a reflection of having been afflicted by serious health and nutrition problems, in a given department of France as follows:

$$S_{jt} = \alpha + \beta \text{Wages}_{jt} + \gamma \text{EdExpenditure}_{jt} + \delta \text{Healthcare}_{jt} + \zeta \text{Inequality}_{jt} + \theta \text{Paris}_t + \dots + u_{jt} [1]$$

where S_j is the share of men below the 1.624 meter cut-off in department j at time t . Among the covariates included in the model is the average industrial wage of workers in the department.¹⁸ This is a measure of the overall economic prosperity of the region. We also had information on the agricultural wage, but the correlation between the agricultural and industrial wage was 0.69, too high to include both the parameters in the model. In addition, when we include the agricultural wage in the models instead of the industrial

¹⁵ See Strauss and Thomas, ‘Health, nutrition and development’ for a complete review of the impact of nutrition, as measured by stature, on productivity. Likewise, there is growing evidence of higher risk of a range of diseases, particularly of heart attack and stroke, among those having been malnourished as a child. See, for example, Barker, *Mothers*, and Osmond *et al.*, ‘Early growth’.

¹⁶ See Strauss and Thomas, ‘Health, nutrition and development’; Strauss, ‘Does better nutrition raise food productivity’; Deolalikar, ‘Nutrition and labour productivity’.

¹⁷ One inch in Ancien Regime France was 2.707 cm, in contrast to the international definition that is employed today.

¹⁸ Ideally we would also include in the model a measure of the distribution of wages. However, no such data are available.

wage, the coefficients are not statistically different from each other. This reflects the high statistical correlation between the two variables, capturing the relatively high degree of labor market integration.¹⁹

While average wage levels are clearly important, so, too, is the distribution of economic welfare. We do not have income distribution data, however. Instead, we use the share of the population that owns land to capture the degree of inequality.²⁰ The concentration of land ownership, the single most important asset in nineteenth century France, is a good indicator of the overall distribution of wealth and income.²¹ Moreover, real asset ownership can serve as a form of insurance in case of health problems.

We also include a variable on education expenditures per capita for children six to 12 years of age as an indicator of the investment of the departments in the human capital of the population. The importance of education and literacy as a determinant of health and nutrition is now widely acknowledged.²² Another covariate we include is the number of health workers (doctors, and pharmacists). The variable is intended to capture the overall level of health services available in the department. We assume that the number of doctors and pharmacists is a reasonable proxy of the provision of health care in a given department. We thus use contemporary yearbooks to find how many health workers were active in each department.²³ Finally, our model includes a dummy variable for Paris given that, like today, Paris is unique across many dimensions, including its degree of congestion and population density.

It was not possible to gather yearly information on the independent variables in our model for each department for each year. We were instead able to gather reliable information on the explanatory variables for two time, one in the first half and the other in the second half of the century.

We initially estimate this model with the dependent variable being the share of stunted men in each department in the last quarter of the century, 1875-1900. The

¹⁹ Bompard *et al.*, 'Migrations saisonnières'; Grantham 'Economic History', Postel-Vinay 'The Dis-integration', Sicsic, 'City-farm wage gaps'.

²⁰ The fiscal administration observed the number of individuals paying the land tax in each municipality (*commune*). At the department level, however, fiscal officials could only aggregate these figures, regardless of the fact that many people owned land in several *communes*. The method therefore has the potential for double counting. However, despite the upward bias in the value of this variable, these estimates are a reasonable proxy of the proportion of those owning land.

²¹ Real estate made up two-thirds of private wealth in the early nineteenth century, about half of it in the 1880s and 1890s and one third before WW I. *Annuaire statistique de la France, Résumé rétrospectif*, 1966, Paris, Imprimerie Nationale, 1966, p. 530.

²² See, for example, Thomas, Strauss and Henriques, 'How does mother's education' and Behrman and Wolfe, 'How Does Mother's Schooling'.

²³ We first considered taking midwives into account as well, but as their role is specific, we decided to leave their case for further research.

explanatory variables, in contrast, are from the following dates: industrial wages, 1860²⁴; education expenditures per primary age child, 1850²⁵; share of landowners, 1858²⁶; and number of health workers, 1851.²⁷ The lag is employed for two reasons. First, conceptually, the achieved stature of young men at the age of 20 is largely a function of their health status at the time of conception through early childhood. In fact, Martorell shows that almost all the growth retardation has its origins in the first two to three years of life.²⁸ In addition, the health literature suggests that growth retardation during this period is not amenable to being compensated for in the form of catch-up during childhood and adolescence, particularly when children continue to reside in poor environments.²⁹

We thus would want to employ data from that period in our reduced form health models. Second, the use of lagged covariates largely mitigates any concern about the possibility of reverse causation – for example, healthier men raising the local wage or contributing to higher tax revenues that finance local education investments.

Beyond simulating the effects of various covariates on the share of stunted men, we also are interested in whether the impact of the explanatory variables on the health of men changed during the course of the century. To do so, we next estimate a second model of the stunting for the first half of the century, 1830 through 1850. Once again we also try to take into account the expected lags between stature at age 20, and the impact of the explanatory variables at the time of conception and early childhood. We incorporated the lag structure into the earlier period model as best we could, given limitations of available data. The dates of the data that correspond to the covariates are as follows: industrial wages, 1838-39-40³⁰; education expenditures per primary age child, 1833³¹; share of landowners, 1825³²; and number of health workers, 1840.³³

²⁴ Statistique de la France. Industrie, *Résultats généraux de l'enquête effectuée dans les années 1861-65*, For a detailed discussion, see J.-M. Chanut *et al.*, *L'industrie française*, p. 80-82.

²⁵ *Statistique de l'enseignement primaire*, t. 2. We are grateful to Cl. Diébolt who generously provided these data to us. See also Grew and Harrigan, *School, State and Society*, chap. 8; Luc, 'L'illusion' and *La statistique*; Briand *et al.*, *L'enseignement primaire*.

²⁶ Statistique Agricole de la France, *Résultats généraux de l'Enquête de 1882*, pp. 278-285.

²⁷ Data on the health workers in 1851 were derived by initially checking the list published by the main commercial directories (*La France médicale* published in 1841 and the *Almanach-Bottin du commerce de Paris, des départemens de la France et des principales villes du monde for 1851*) against more detailed departmental directories wherever they are available. This procedure suggests that both the *France médicale* and the *Almanach* of 1851 provide a reliable proxy of the spatial distribution of health workers in France during the first part of the nineteenth century.

²⁸ See Martorell, 'Results and implications'; Strauss and Thomas, 'Human resources: Empirical models of household decisions'.

²⁹ See, for example, Martorell *et al.*, 'Reversibility'; Martorell, 'The nature of child malnutrition'; Simondon, *et. al.*, 'Preschool stunting'; and Hoddinott and Kinsey, 'Child growth'.

³⁰ Statistique Générale de la France. *Industrie, 1847-1852*. For a detailed discussion, see J.-M. Chanut *et al.* *L'industrie française*, pp. 70-80, 82.

³¹ See note 23.

³² For a discussion of these fiscal data, see Vigier, *Essai sur la répartition*. For simplicity, we rely here the data for 1825 published in Joanne, *Dictionnaire*.

Beyond examining and interpreting the coefficients for the two period models we decompose the change in the share of unhealthy and malnourished into the endowment and returns effects. To amplify, we have linear models of the share of short people, call it the health production functions, with the same functional forms for the two periods, but that have possibly different coefficients and error variances:

$$s_1 = x_1\beta_1 + \varepsilon_1 \quad [2]$$

$$s_2 = x_2\beta_2 + \varepsilon_2 \quad [3]$$

where s_t is the share of short persons in time t , x_t is a vector of determinants, including a constant, and ε_t is a zero-mean, i.i.d. error. It is possible to decompose the mean difference in the expected value of the outcome variable (the share of short persons) as follows:

$$E[s_2 - s_1] = E[x_2\beta_2 + \varepsilon_2 - x_1\beta_1 - \varepsilon_1] = (E[x_2] - E[x_1])\beta_2 + E[x_1](\beta_2 - \beta_1) \quad [4]$$

The expected value of the difference in periods 1 and 2 is decomposable into two terms. The first term, $(E[x_2] - E[x_1])\beta_2$, is the period 1 and 2 difference in the expected value of the determinants multiplied by their effect on the share of short (unhealthy) people – which we can label the “endowment effect” because it shows the contribution to the mean gap of differences in mean levels of the variables determining the outcome.

The second term, $E[x_w](\beta_2 - \beta_1)$, captures the impact of period 1 and 2 differences in the impact of the x 's on the share of short persons. We can interpret this as showing the extent to which the "returns" to x (including the constant) differ by time periods.

III. DATA

Since the French Revolution, the measurement of all young men was performed routinely as part of conscription. We have been able to gather detailed information on the intervals of heights, or bins, in which all 20-year-old males fall for most years during the period 1819 to 1900, for 82 departments. For the period 1819 to 1830, local information on conscripts was summarized at the department level and reported to the Ministry of

³³ As published in *La France médicale* (1841).

War in Paris. The manuscript reports were later deposited in the National Archives.³⁴ In the 1960s, Le Roy Ladurie made a first effort at collecting data on heights from these reports, and his 1972 book relied heavily on this source.³⁵ The dataset was organized and kept by M. Demonet who generously provided it to us, and we completed it as much as possible. After a brief gap between 1830 and 1836, the same information was published for all departments on a yearly basis in the *Comptes rendus statistiques et sommaires*. This is the source of the data on heights for all the remaining years of the nineteenth century. David Weir had compiled these data for the years 1836, 1840, 1846, 1856, 1860, 1866, 1875, 1886 and 1895 and generously shared it with us. For the other years we compiled them ourselves.

We present the means and standard deviations in Table 1 for all covariates used in the models. In addition, Figure 1 presents the shares of stunted conscripts between 1819 and 1900.³⁶ We present these data distinguishing between the northeastern and southwestern part of the country. The far greater share of stunted men in southwestern France during the nineteenth century is consistent with the earlier work of authors like Dupin and d'Angeville, or more recently, Le Roy Ladurie, who have underscored a heuristic frontier from St Malo to Geneva that separated taller North-Eastern Frenchmen and shorter South-Western Frenchmen.³⁷ But, perhaps of greater interest is that the proportion of short persons is declining at a more rapid pace in the southeast than in the northwest. In addition, the figure shows plots from two regions in France, “East” and “Massif Central.” The East covers three departments (three percent of the surface area of France, with four percent of the population and Besançon being the largest town) and the Massif Central covering six departments with eight percent of the surface area and seven percent of the population, and Clermont Ferrand being the largest town³⁸. We selected them because they exemplify regions with particularly high and low levels of stunted men across the century, and illustrate that, as expected, the greater the regional disaggregation, the more extreme are the differences in the shares of men falling below the height threshold.

³⁴ First, we checked the Le Roy Ladurie data set on the original manuscript reports in the Archives Nationales (Archives Nationales F9 150-261). Second, we completed it because yearly reports that are missing in the Archives Nationales are often kept in departmental Archives..

³⁵ See Bernageau *et al.*, ‘Le conscrit’; Aron *et al.*, *Athropologie du conscrit*; Demonet *et al.*, ‘Anthropologie de la jeunesse’.

³⁶ There are two gaps in our series. As mentioned before, there is one between 1830 and 1836. Data is also missing between 1866 and 1872 due to the war of 1870-71 and to institutional changes introduced just before or just after the war.

³⁷ Dupin, *Le petit producteur*, d'Angeville, *Essai sur la statistique*, or more recently, Le Roy Ladurie, *Le territoire de l'historien*.

³⁸ The departments of the “East” regions are: Doubs, Jura, Haute-Saone; the departments of the “Massif Central” are: Allier, Cantal, Corrèze, Creuse, Puy-de-Dôme and Haute Vienne. The population figures are those in 1836.

IV. ECONOMETRIC RESULTS

The regression results for the models are found in Table 2. Overall, F-tests rejected that the models are the same at the 5 percent level. Our examination of the differences in individual parameters between the models of shares of stunted men in the period 1830-1850 versus 1875-1900 suggests that, first, the Paris dummy is significant and negative in both periods, with the magnitude being far greater in the second half of the century. As one would expect, statistical comparisons of the Paris coefficient reveal that they differ statistically across time periods.

There are several complementary explanations for the fact that there was more stunting in Paris than elsewhere, and they revolve around the evidence from a large body of literature that shows that the immediate causes of growth faltering are poor diets and infection, and the synergistic interaction between the two.³⁹

More specifically, during much of the 19th century Parisian residents were unable to rely on home consumption while they were subject to the vagaries of food markets with higher prices than elsewhere. In 1852, for instance, according to the budget data published by *The Statistique Générale de la France*, food prices were 30% higher in the capital city than on average.⁴⁰ A second explanation is likely found in the poor sanitary conditions and lack of clean water in the crowded neighborhoods of Paris which, like in other large European cities, contributed to greater infection and disease, and thus stunting of growth. This stronger effect in the latter half of the century occurs as the population density of Paris rose dramatically and more rapidly than other regions of the country⁴¹, while modern practices of waste disposal and water treatment were far from improving at the same pace. Moreover, living conditions worsened over the century in the poorer parts of the city where the population grew the quickest. As a result, the health of native Parisians suffered severely during the second half of the century.⁴² It is noteworthy that despite the health costs of moving to Paris, economic opportunities and other amenities of life in the capital more than compensated to make it, like other large cities in Europe, desirable destinations.⁴³

³⁹ See, for example, Mosley and Chen, ‘An analytical framework’, and Scrimshaw, ‘Historical concepts’.

⁴⁰ *Statistique agricole* (1858-1860).

⁴¹ The population of Seine, with its reasonably stable boundary, is a good proxy for examining changes in population density of Paris. It took three centuries, from 1500 and 1800 for the population to double. However, it doubled in the next 50 years (between 1800 and 1850), and then increased nearly five fold between 1850 and 1900. Clean water supplies and sewage treatment and disposal were not able to keep pace with these increases. For more details on urban public health policy and their role on mortality transition see Goubert *La conquête de l'eau*; Ferrie and Troesken ‘Water’.

⁴² See Jacquemet, ‘Urbanisme parisien’ and *Belleville*; Goubert, *La conquête de l'eau*; Farcy and Faure, *La mobilité*, 121-37 and, especially, 130. See also Gaillard, *Paris, la ville*, pp. 156-7; and Soudjian, ‘Quelques réflexions’.

⁴³ See Humphries and Leunig, ‘Dick Whittington’. Given that Paris was growing relative to other regions in large measure due to migration, this raises the concern that migration across

In keeping with our expectations, we find that as industrial wages increase, the share of the population who is stunted declines. Statistical tests reveal no significant difference in the wage parameters across the two models corresponding to the earlier and later parts of the century. Similarly, departments with a higher level of expenditures per child on primary education have fewer stunted men in subsequent years. This finding is consistent with the large literature on the impact of education on health status, and particularly height for age.⁴⁴ This is not because health or childcare practices are taught in school, but rather that educated mothers are better able to acquire and process information about providing for the health and nutritional needs of their children.⁴⁵ It is also noteworthy that, unlike the wage variable, the magnitude of the education parameter declined markedly across the two time periods, a difference that was statistically significant. This suggests that there are decreasing returns to education in terms of health outcomes, again something that is intuitively appealing and consistent with what has been found in the literature.

The two other variables included in our models, the number of health care workers and the share of individuals paying land taxes, also have the expected negative signs. In the case of the former, departments with more health care workers have healthier populations.⁴⁶ The increase in the health care coefficient over time was statistically significant. It is interesting to speculate further on the mechanisms by which health workers affected health status, especially given the primitive state of medicine in the 19th century. While the presence of midwives likely diminished infant mortality and improved neonatal outcomes, it is also the case that the service offered by doctors was in high demand, even if only a minority had easy access to doctors, especially in the first part of the century. Two changes progressively occurred, however. First, the number of

departments could contaminate our results. While there is no way to adjust our estimates to deal with this, we do not think it is a major issue. One reason is that around 90 percent of migration occurs among individuals after their 20th birthdays, or the date of conscription (see Kesztenbaum, 'Cooperation and coordination', p. 91).

⁴⁴ See Behrman and Deolalikar, 'Health and Nutrition'; Thomas, Strauss, and Henriques, 'Mother's education'; Thomas and Strauss, 'Prices, infrastructure', Barrera, 'Maternal schooling'; Handa, 'Maternal education and child height'. The strong positive impact of, particularly mothers' education, on children's health and nutrition outcomes, and on the use of key inputs to health such as medical care, is found even when controlling for the level of household income. See Sahn, Younger, and Genicot, 'Demand'; Strauss and Thomas, 'Human resources'.

⁴⁵ See, for example, Thomas, Strauss, and Henriques, 'Mother's education'; Glewwe, 'Why does mother's schooling raise child health?'

⁴⁶ Of course, there is always a concern about reverse causation, that is, the possibility that more health workers capture a worse disease environment. Indeed this would be a serious concern if we were using contemporaneous data on health workers and health outcomes. However, we are instead using the number of health workers lagged a generation. Nonetheless, to the extent that a higher number of health workers is in any way capturing a worse health environment, this would bias upward the results on the coefficient, meaning that the results can be interpreted as a lower bound to the effect of health care workers.

doctors grew significantly. Second, and perhaps of greater importance, the quality of the medical work force improved dramatically over time. During the first part of the century, doctors with a formal medical degree were only a small fraction of those practicing medicine, especially in the countryside. (Madame Bovary's husband in Flaubert's novel is a classic example of these health professionals who were at best able to manage simple cases⁴⁷). More specifically, nearly three fourth of the medical workforce at the beginning of the century did not have formal training from medical schools. This figure dropped to 40 percent in 1850 and 13 percent in 1890.⁴⁸ We are thus not at all surprised to find that the coefficient on health care workers shows an improvement in the latter half of the century

Finally, those departments with a larger share of individuals paying land taxes, an indicator of greater asset and income equality, also have a smaller share of stunted men. This is sensible and consistent with the literature on health inequality that highlights the diminishing returns to health of increases in incomes – that is, that health is a concave function of income.⁴⁹

To gain some insight into the magnitude of the impact of individual parameters, we present the results of the predicted share of the stunted population by simulating what happens when the various values (or Xs) on parameters are set to equal the mean for the lowest and highest decile of that variable, with all other covariates being set at the means of the sample of 82 departments. In the models for the second half of the century, we can see, for example, that the average share of stunted men across all the departments is 30.8 percent (Table 3). If the value for the industrial wage was the average of the lowest decile of the wage distribution among the 82 departments (basically, the average wage of the eight departments with the lowest wage), the predicted share of stunted men would reach 33.3 percent. In contrast, if mean wages in a department were equal to the mean of the eight departments with the highest wages, the share of stunted men would be 27.5 percent, again, holding the value of all the other covariates at the mean.

Focusing on the Period 2 results, the difference in the predicted share of stunted men between the lowest and highest decile when conducting a simulation using different values of the education expenditure variable is around the same order of magnitude. The difference across the decile in the predicted share of conscripts that are stunted is substantially greater for the health care variable, a result driven largely by the low values in the bottom decile of the distribution. For the final parameter in the model, our asset distribution variables, the spread in the predicted shares of stunted men is around 10 percent when using the values of the lowest and highest deciles of that variables distribution. These large differences indicate that all parameters are both statistically and

⁴⁷ Bovary, is not qualified enough to be termed a doctor, but is instead a "health officer". When he is persuaded by the local pharmacist to attempt an operation on a patient's clubfoot, the effort is an enormous failure. The outcome was that after mauling the patient, his leg must be amputated by a real doctor.

⁴⁸ Jaisson, 'L'honneur perdu du généraliste'. Léonard, *La France médicale au XIXe siècle*.

⁴⁹ See Preston, 'The changing relation'; Deaton, 'Health, inequality'.

economically significant – that is, the values of these variables make an important difference in terms of the predicted share of malnourished men.

We next turn to the results of our inter-period decomposition exercise in Table 4 which presents the decomposition of the mean difference in the expected value of the outcome variable (the share of short conscripts in the early and later parts of the nineteenth century) into the endowment and returns effects. First, examining the impact of changes in endowments (or the Xs), it is clear that the most important factor in driving an improvement in heights is the increase in wages. This comprises approximately one-third of the overall contribution of the endowment effect.

The second most important contribution to changes in the endowment comes from the improvement in education. One-quarter of the overall decline in the share of stunted conscripts can be attributed to increased level of spending on education of primary school children. In considering this large and distinctive contribution to the decompositions, the results can largely be explained by the fact that spending for primary education at the beginning of the century was low and mostly private.⁵⁰ However, this soon changed as there were large spending increases of the state that contributed to marked improvements in the overall share of literacy, which increased from around 45 percent in 1827-29 and 66 percent in 1851-55 to 94 percent in 1893-96.⁵¹

Improvements in the number of health care workers and improving asset distribution each contribute around 18 percent to the overall decline in the share of stunted men. In the case of the role of health care services, this contribution may appear strikingly small. One has to keep in mind, however, that health care services were severely rationed and the poor had little if any access to them throughout the nineteenth century, in contrast to those who could afford to pay for private provision of services. The principle of universal access is indeed a twentieth century institution. In this respect, it is no surprise that the impact of the endowment changes in this variable has a small effect.

The improving distribution of asset and its similarly modest impact also warrant further comment. As Table 1 shows, the share of the population which owned land was large and increasing: 32% in the first period to 39% in the second.⁵² However, the majority of those who owned land owned very small plots yielding modest incomes. In fact, 20 to 25 percent of them owned plots that hardly generated any significant income at

⁵⁰ See Carry, 'Le compte satellite' and Lindert, *Growing Public*.

⁵¹ Furet and Ozouf, *Lire et écrire*, II, p. 280 (here literacy is measured by the share of conscripts able to read).

⁵² To be sure, fiscal officials knew only too well that they overestimated the number of landowners. In fact, they were so keenly aware of this bias that, using a rule of thumb, they often divided these estimates by 1.2 to have a more realistic estimate. If we follow the same rule, the proportion of individuals owning land remains relatively high, however: 26 % in the first period and 37 % in the second period.

all and were certainly unable to provide insurance in lean years.⁵³ It is thus safe to say that a large proportion of those who lived in the countryside and owned land remained inadequately protected by their assets.

When we examine the changes in returns effects, they are positive for the wage and education parameters, implying that the positive returns effects of both of these factors, especially education expenditures, are declining quite markedly. We were somewhat surprised by the magnitude of the declining importance of education as a determinant of health outcomes, despite that we expected the returns to be a concave function. We therefore tried substituting the expenditure variable with another district level mean, the share of conscripts who are literate. In the case of this literacy variable, a dramatic decline in the size of the coefficient was also observed, although, the magnitude of the decline was somewhat less than the education expenditure variable. Given the robustness of the findings with respect to the marked reduction in the education coefficient across time periods, one possible explanation is that government spending succeeded in the early part of the century in as far as it “lessened the gap between poorer and wealthier departments” in terms of access to education.⁵⁴ Beyond increased spending, however, there was a limit to what national policy was able to achieve in terms of reducing “other structural or cultural factors” to educational attainment.⁵⁵ As a result, the departmental returns to government efforts in education, and its effect on health, diminished over time.

Unlike the wage and literacy values in the decomposition results, the returns to health care and inequality parameters are increasingly important over time. That is, the positive influence of these variables (i.e., their role in decreasing the share of stunted conscripts) is more influential in the latter than former period. However, despite the interest in the signs of the decomposition coefficients, the most noteworthy finding is that unlike the endowment effects, these are very small, and as discussed previously, are often not statistically different from each other.

Finally, the magnitude of the constant is quite large and, as expected, negative. The constant is capturing the totality of effects of changes in unmeasured factors that are contributing the declining share of stunted men in the departments of France. By implication, if the endowments were held constant, the changes in the betas would have contributed to an overall increase in share of malnourished men, but this change would have been largely mediated by the constant, rather than returns to the parameters in the model.

⁵³ In 1858, 51 % of the “landowners” owned plots that generated an income lower than 5 FF (and 4.77 % of the total income). See *Résultats généraux de l’Enquête de 1882*, pp. 278-85.

⁵⁴ Grew and Harrigan, *School, State and Society*, p. 227.

⁵⁵ *Ibid.*

V. CONCLUSION

In our paper we have attempted to examine and explain the rather marked improvement in the health of French males during the nineteenth century. Our health indicator is the share of short conscripts in France's 82 departments whose stature at the time of universal conscription at 20 years of age is outside the range presently associated with good health and adequate nutrition. We argue that the use of the share of men falling below a normative threshold in terms of stature reflects the extent of nutritional stress and infectious disease in the highly disaggregated regions of the country. We further argue that looking at the share of short men is an improvement upon simply examining mean heights, or a measure of central tendency in the population, as is the practice in the literature. We focus on examining the trends and the determinants of the share of stunted men over the course of the century, and decompose the determinants into levels and returns to the parameters in the models.

We find a dramatic decline in the percent of the population that is stunted across the 80 years for which we have data. The decline in the share of short 20-year-old men is particularly large in the southern region of the country, where stunting levels at the beginning of the century were markedly higher than the wealthier northern departments. This implies that the steady improvements in material well-being were accompanied by improvements in the healthiness of the population.

In examining the underlying factors that contribute to this reduction in the share of men with heights falling below the threshold normally associated with good health and nutrition, we find that education (both spending on education and literacy) is of importance, along with the impact of wages, availability of health care workers, and the share of households with access to land, which serves as a form of insurance as well as a reflection of asset holding. The fact that there is more stunting in Paris, controlling for other covariates, is consistent with the findings reported elsewhere that urbanization contributed to worse nutrition and health, reflecting the higher food prices and the greater spread of pathogens in congested urban settings.

Our decomposing the impact of these factors also shows that the improvements in the health of the population are disproportionately due to changes in endowments, such as wages and levels of education. In fact, there is a marked decline in returns to endowments over time, particularly education, and to a lesser extent industrial wages. Similarly, living in Paris became an increasingly important health liability as the century progressed.

The results in this paper add to the literature on the debate over when and why heights increased in Europe. Our use of data on the economic and social position of the departments, with the covariates lagged to the period in which the men were conceived and were young children, makes a strong case for the importance of economic conditions, as well as public policy in the form of spending on social services as being paramount in determining the health of the population. That being said, despite our examination of the more proximal determinants in our models, we also acknowledge that underlying factors,

such as the relative peace that prevailed in Europe at the end of the Napoleonic Wars in 1815, and technological change in agriculture and public health practices may contribute to the role of factors such as education and earnings in effecting improvements in health. Exploring the roles of these factors is certainly an important area for continued research. However, the relative stability of the parameter estimates in our models suggest that there were not large scale changes in the health production process during the nineteenth century, but rather a more general improvement in economic and social conditions that contributed to improved health.

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TABLES

Table 1. Mean, Standard Deviations of Variables

Variable	Obs	Mean	Std. Dev.	Mean	Std. Dev.
		Period 1		Period 2	
% Stunted	82	37.6	0.08	30.8	0.07
Industrial daily Wages*	82	1.91	47.0	2.38	47.9
% Land-owners	82	33.1	10.9	38.5	11.8
Ed. Exp. per primary student*	82	2.4	0.90	2.8	1.3
Nb. of Health Care Workers	82	175	16.3	264	46.0

* in French Francs

Table 2. Model of the Share of Stunted Conscripts

Variable	Period 1	Period 2
Paris dummy	0.171 [1.53]	0.575 [3.26]**
Industrial Wages	-0.446 [2.80]**	-0.350 [12.31]**
Ed. Exp	-0.422 [4.49]**	-0.097 [1.68]+
Nb of. Health Care Workers	-0.129 [1.76]+	-0.149 [3.18]**
Share of Land-owners	-0.179 [2.16]*	-2.39 [3.43]**
Constant	0.642	0.543
Observations	82	82
R-squared	0.52	0.45

Absolute value of t statistics in brackets

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 3. Predicted Share of Stunted Conscripts Using Lowest and Highest Decile Values for Covariates

Actual	Industrial Wage		Educational Expenditures		Health Care Workers		Share of Landowners		
	bottom 10%	Top 10%	bottom 10%	Top 10%	bottom 10%	Top 10%	bottom 10%	Top 10%	
coeff*									
mean									
<i>% Stunted</i>									
Period 1	0.3761	0.4029	0.3328	0.4262	0.3029	0.3908	0.3354	0.4061	0.3405
Period 2	0.3076	0.3326	0.2747	0.3236	0.2825	0.3356	0.1901	0.3590	0.2569

Table 4. Decomposition of Changes in the Share of Stunted Conscripts

Variable	Contribution in percent to total change in the share of stunted conscripts
Endowment effect	
Industrial Wages	-2.1
Ed. Exp.	-1.6
Nb. of Health Care Workers	-1.1
Share of Land-owners	-1.2
Total	-6.0
Returns effect	
Paris dummy	0.5
Industrial Wages	2.3
Ed. Exp	9.1
Nb. of Health Care Workers	-0.5
Share of Land-owners	-2.3
Constant	-9.9
Total	-0.1

FIGURE

Figure 1. Plots of Share of stunted conscripts (5 year moving average)

