# Health and Welfare in Nineteenth-Century France

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France in 1817:

“All was radiant. It was an undeniable time of peace and royalist safety; it was the time when a report of a police chief to the king on the suburbs of Paris ended with these lines: “There is nothing to fear these people. They are carefree and indolent like cats. [...] They are all small men. Lord, one would need two of them end to end to make one of your grenadiers. [...] It is remarkable that body-height has fallen in this population during the last fifty years; its stature is smaller than before the revolution. This people is not dangerous. All things considered, it is made of good rabble.”

Victor Hugo, *Les Misérables*

Purpose

Empirical

- Distribution and evolution of health in nineteenth-century France
- Using body-height data as a proxy variable for health and welfare
  - Evolution over the century
  - Association with crises
  - Association with location
Methodological

- Using histogram-type sample data to make inferences on population distributions
  - Estimate continuous population distributions with maximal parametric flexibility
  - Compare means and distributions
  - Use richness of data to take into account the presence of both sampling and (possible) measurement errors

Height as net welfare

Stature captures “multiple dimensions of the individual health and development and their socio-economic and environmental determinants” (Beaton et al. 1990)

- A clear manifestation of living standards over the last centuries: a dramatic change in stature in many regions of the world
- Changes on which there does exist ample historical quality information
- Body-height constitutes a measure of nutrition during the growth phase — net of intensity of labor and other factors (such as illness and stress)

Also:

- Stature further takes into account the health status of the mother during pregnancy, the quality of sleep, public health, personal hygiene, as well as health technology and the organization of work
- Height more influenced by the intake of proteins (“quality of nutrition”) than by that of calories
- In the case of illness, the availability of an adequate diet during convalescence is as important as the severity of the disease
Description

Source: conscription registries of the French army

Period: 1819 to 1900

Territory: the 90-some departments (regions) of France

Selection method: “nearly” random draw (or complete census after 1872) of all 20-year-old men

Screening: involved a physical examination undertaken by local officials and including the measurement of stature

Number of data sets: 6369

Number of men measured each year: between 25% and 100% of 20-year-old male population (80 000 to 300 000 individuals per year)

Data: bins of heights

Health in France

Marseille – 9 / 23

Health in France

Marseille – 10 / 23
Methodology

Estimation of the population distributions

- Move from bin data → continuous distributions

- Solution of systems of $C - 1$ equations with $C - 1$ unknowns

$$F(\bar{x}_c; \hat{\Theta}) - F(\underline{x}_c; \hat{\Theta}) = \hat{H}_c$$

$\hat{\Theta}$: vector of estimated parameters
$\underline{x}_c$ and $\bar{x}_c$: upper and lower bounds
$\hat{H}_c$: proportion of heights between the bounds
$F$: mixture of normal distributions

$$F(x; \alpha_1, \alpha_2, \alpha_3, \mu_1, \mu_2, \mu_3, \sigma_1, \sigma_2, \sigma_3)$$
$$= \alpha_1 \Phi \left( \frac{x - \mu_1}{\sigma_1} \right)$$
$$+ \alpha_2 \Phi \left( \frac{x - \mu_2}{\sigma_2} \right)$$
$$+ (1 - \alpha_1 - \alpha_2) \Phi \left( \frac{x - \mu_3}{\sigma_3} \right)$$

$\Phi$: distribution function of the standard normal distribution
$\alpha_d, \mu_d$, and $\sigma_d$: weight, mean, and standard error of normal distribution $d$

Choosing $D = C/3$ normal distributions
Comparison of distributions

- Poverty comparisons depend on the choice of lines and indices

- First-order poverty dominance

\[ P_A(z) \geq P_B(z) \quad \forall \ P(z) \in \Pi^1(z^+) \]
\[ \iff \ F_A(x) \geq F_B(x) \quad \forall \ x \in [0, z^+]. \]  

(3)

\( \Pi^1(z^+) \) includes all poverty indices \( P(z) \) respecting monotonicity and symmetry principles, with \( z \) not above \( z^+ \)

- Restricted first-order poverty dominance:

Comparison restricted to \( [z^-, z^+] = [1.53, 1.78] \approx 3^{rd} \) to \( 97^{th} \) percentile

Null and alternative hypotheses for the distribution dominance tests:

\[ H_0 : \quad F(z_1; \hat{\Theta}_A) \leq F(z_1; \hat{\Theta}_B) \]

or

\[ \ldots \]

or

\[ F(z_m; \hat{\Theta}_A) \leq F(z_m; \hat{\Theta}_B) \]

(4)

versus

\[ H_1 : \quad F(z_1; \hat{\Theta}_A) > F(z_1; \hat{\Theta}_B) \]

and

\[ \ldots \]

and

\[ F(z_m; \hat{\Theta}_A) > F(z_m; \hat{\Theta}_B), \]

(5)

- Use the test statistics

\[ \frac{F(z; \hat{\Theta}_A) - F(z; \hat{\Theta}_B)}{\sqrt{\hat{\text{var}}(F(z; \hat{\Theta}_B)) + \hat{\text{var}}(F(z; \hat{\Theta}_A))}} \]

(6)

- Expressions \( \hat{\mu}, \hat{\text{var}}(\hat{\mu}), F(z; \hat{\Theta}_A) \) and \( \hat{\text{var}}(F(z; \hat{\Theta}_A)) \) are readily computed once the parameters \( \hat{\Theta} \) in system (1) are estimated.

- Since \( \hat{\Theta} \) contain the maximal number of parameters that can be estimated from our data, the sampling distribution of these statistics is also as distribution-free as it can be.
Health in France in the 19th century

Upward trend, but not constant, and considerable variation across departments

- upward global trend

- variation across departments
Comment on year-to-year variability

Table 1: Proportions of departments statistically dominating (or dominated by) the preceding year

<table>
<thead>
<tr>
<th>Year</th>
<th>% of departmental means</th>
<th>(continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dominating</td>
<td>dominated by</td>
</tr>
<tr>
<td>1820</td>
<td>31.3</td>
<td>7.5</td>
</tr>
<tr>
<td>1821</td>
<td>11.8</td>
<td>26.3</td>
</tr>
<tr>
<td>1840</td>
<td>15.1</td>
<td>32.6</td>
</tr>
<tr>
<td>1841</td>
<td>22.1</td>
<td>24.4</td>
</tr>
<tr>
<td>1854</td>
<td>12.8</td>
<td>46.5</td>
</tr>
<tr>
<td>1855</td>
<td>30.2</td>
<td>25.6</td>
</tr>
<tr>
<td>1859</td>
<td>29.1</td>
<td>22.1</td>
</tr>
<tr>
<td>1860</td>
<td>19.8</td>
<td>19.8</td>
</tr>
<tr>
<td>1861</td>
<td>21.4</td>
<td>25.8</td>
</tr>
</tbody>
</table>
Sources of variability

- Not from estimation method, since also present with headcounts
- Sample variability: standard error of order of 0.15 cm
- Measurement errors: standard deviation of around 0.23 cm
- Real variability: a standard deviation of 0.23 cm in the distribution of (true) population average heights would suffice

Evolution from beginning to end of century

Compare the distributions of the first ten years of available data (1819–1828) with those of the last ten years (1891–1900)

<table>
<thead>
<tr>
<th>Mean</th>
<th>Distributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>93.8%</td>
<td>35.6%</td>
</tr>
</tbody>
</table>

Dominance in distribution depends on bounds
Effect of crises

- year-to-year comparisons
- period-to-period (1846-50 and 1873-92) comparisons
  - "infancy" and "pre-adult" effects

Results
No statistically significant effects;
Possible reasons:
- order of magnitude of impacts swamped by sampling variability and measurement errors on estimators

Paris vs suburbs

Health in Paris evolved differently than in neighbouring departments

Results

<table>
<thead>
<tr>
<th>Period</th>
<th>Other dep.</th>
<th>Paris</th>
<th>Other dep.</th>
<th>Paris</th>
</tr>
</thead>
<tbody>
<tr>
<td>1819 - 1900</td>
<td>69.7%</td>
<td>17.0%</td>
<td>16.4%</td>
<td>2.6%</td>
</tr>
<tr>
<td>1819 - 1830</td>
<td>21.7%</td>
<td>56.6%</td>
<td>3.6%</td>
<td>8.4%</td>
</tr>
<tr>
<td>1836 - 1886</td>
<td>82.1%</td>
<td>5.6%</td>
<td>20.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1890 - 1900</td>
<td>58.0%</td>
<td>28.4%</td>
<td>5.7%</td>
<td>9.1%</td>
</tr>
</tbody>
</table>
## North-East vs South-West

The North-Eastern and South-Western regions

### Results

<table>
<thead>
<tr>
<th></th>
<th>Dominance in means</th>
<th>Dominance in distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North-E.</td>
<td>South-W.</td>
</tr>
<tr>
<td>1819 - 1900</td>
<td>86.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td>1819 - 1900 (without Paris)</td>
<td>86.9%</td>
<td>5.6%</td>
</tr>
<tr>
<td>1819 - 1828</td>
<td>87.5%</td>
<td>4.2%</td>
</tr>
<tr>
<td>1891 - 1900</td>
<td>85.6%</td>
<td>7.6%</td>
</tr>
</tbody>
</table>

Health in France

Marseille – 21 / 23
Lessons

Two main empirical questions regarding the stature of the French during the nineteenth century:

- How did it evolve over the course of the century?
- Were there regional and geographical correlates with body-heights?

A few methodological contributions stimulated by both limitations and richness of data:

- more than 6000 department-year distributions (representing around 15 millions young Frenchmen)
- over close to a century
- estimation from grouped data (could be applied to other types of grouped data) while making maximal use of the available empirical information
- statistical tests of differences-in-means and stochastic dominance (allowing for low power of the latter tests)
- allow for the presence of both sampling and non-sampling errors

Could help answer other distributive questions on poverty and inequality, for which the entire distributions are needed