

## Much Ado about Nothing?

*Reconsidering the Smallpox Effect. Height in the Nineteenth-Century Town of Thielt, Belgium*

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### Abstract

Anthropometric evidence such as height has been considered a major indicator of the social and economic well-being of past societies. To understand differences in attained height, the role of several determinants has been widely discussed. Since the 1990s, the impact of disease has shown to be a promising topic. In particular, research on the effect of smallpox on the height of the population in nineteenth-century England has triggered heated debate. Voth and Leunig argue that smallpox stunted height, but their results have been called into serious question by scholars such as Oxley, Razzell, Heintel and Baten. In this article, we introduce new sources and evidence for Thielt, a small rural town in Belgium. By linking military registers with smallpox listings, our analysis allows for a nuanced study of the height of conscripts. In early nineteenth-century Thielt, height differences between smallpox survivors and those who did not fall prey to the disease appear to be largely the result of household circumstances. By taking into account individual and familial attributes, we show the importance of the father's death and father's occupation for the son's height. However, smallpox did not have a statistically significant effect on height.

## Introduction

Since the mid-1980s, the new discipline of historical anthropometry has made impressive contributions to a number of scholarly debates,

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particularly to those on the history of the standard of living.<sup>1</sup> As conventional monetized indicators such as wages, prices and per capita income proved inadequate for answering questions about eighteenth- and nineteenth-century living standards, alternatives were sought in anthropometric measures.<sup>2</sup> Height proved particularly useful for identifying changes in welfare during industrialization in England. A particular pattern of stature variation, known today as the 'early industrial growth puzzle', shows that in the early stages of industrialization the biological well-being of the population in England did not improve, and for some groups it even deteriorated.<sup>3</sup> Contrary to what had previously been assumed, Floud, Fogel and Harris revealed that there was in fact no unidirectional upward trend in the height of people in England after 1750.<sup>4</sup> Although the English case has highlighted the importance of height as an indicator of health and wealth, historical anthropometry has received considerably less attention with respect to the Low Countries, and Belgium in particular.<sup>5</sup>

Historical anthropometry emphasizes that well-being encompasses more than just material welfare. The World Health Organization describes average height as one of the best measures of overall health con-

1 T. Cuff, 'Historical anthropometrics', *EH.Net Encyclopedia* (2010), <https://eh.net/encyclopedia/historical-anthropometrics/> (last accessed 22 May 2017); L. Heyberger, *L'histoire anthropométrique* (Bern 2011).

2 R. Floud et al., *The changing body: Health, nutrition, and human development in the western world since 1700* (Cambridge 2011); R. Steckel, 'Heights and human welfare: Recent developments and new directions', *Explorations in Economic History* 46 (2009) 1-23; J. Komlos and J. Baten, 'Looking backward and looking forward: Anthropometric research and the development of Social Science History', *Social Science History* 28:2 (2004) 191-210.

3 J. Komlos, 'Shrinking in a growing economy? The mystery of physical stature during the Industrial Revolution', *Journal of Economic History* 58:3 (1998) 779-802.

4 R. Floud, K. Wachter and A. Gregory, *Height, health and history: Nutritional status in the United Kingdom, 1750-1980* (Cambridge 1993).

5 For the Netherlands, we can refer to V. Tassenaar, *Het Verloren Arcadia. De biologische levensstandaard in Drenthe, 1815-1860* (Capelle a/d IJssel 2000); H. de Beer, *Voeding, gezondheid en arbeid in Nederland tijdens de negentiende eeuw. Een bijdrage tot de antropometrische geschiedschrijving* (Amsterdam 2001) and the recently started large-scale research project *Giants of the Modern World. A new history of heights and health in The Netherlands 1811-1940* (main supervisor Jan Kok). For Belgium, there are publications by A. Quetelet, *Sur l'homme et le développement de ses facultés ou essai de physique sociale* (Brussel 1836); C. Vandenbroeke, 'De keurlingenlijsten als sociaal-demografische meter', *De Leiegouw* (1981) 235-273; G. Alter, M. Neven and M. Oris, 'Stature in transition: A micro-level study from nineteenth-century Belgium', *Social Science History* 28:2 (2004) 231-247; I. Devos, *Allemaal beestjes. Mortaliteit en morbiditeit in Vlaanderen. 18de-20ste eeuw* (Gent 2006). These studies are either very limited in scope or do not provide a long-term view. However, we can refer to Ewout Depauw (Ghent University), who is currently finishing a doctoral dissertation on heights in nineteenth-century Flanders.

ditions within a society.<sup>6</sup> An individual's attained height is the result of an interaction between genetic endowment and environmental effects during childhood and adolescence. At the individual level, the effect of genetics is strong, but when we look at groups of people over long periods of time, environmental influences predominate. In fact, average height is a net measure: not only does it incorporate nutritional experience, but it also takes into account less tangible and negative influences, such as physical exertion and disease exposure. In this sense, stature captures the biologically relevant component of welfare. Disease and malnutrition, for instance, can cause lifelong growth deficiencies and stunting.<sup>7</sup> In this article, we examine the impact of one particular disease, namely smallpox, on height in nineteenth-century Belgium.

Smallpox is a highly contagious disease caused by the *variola* virus and transmitted by direct human contact.<sup>8</sup> Like many other infectious illnesses, it emerged in human populations during the Neolithic period and has plagued human populations for thousands of years. It has caused disastrous epidemics, and is believed to have almost wiped out the native population of the New World. Smallpox was likely present in Europe from about 300 AD and continued spreading across the continent for centuries.<sup>9</sup> During the eighteenth century, when the disease reached its peak, hundreds of thousands of Europeans died annually as a result of the disease. As one of the deadliest viruses known to humans, smallpox epidemics had an overall mortality rate of nearly 30 per cent, with children being the primary victims.<sup>10</sup> Consequently, prevention was mainly aimed at children. By the mid-eighteenth century, the practice of inoculation was widespread.<sup>11</sup> However, it was the discovery of a vaccine for smallpox by Edward Jenner that led to vaccina-

6 J. Tanner (ed.), *Foetus into man. Physical growth from conception to maturity* (London 1978).

7 B. Bogin, *Patterns of human growth* (Cambridge 1999).

8 Symptoms start one to two weeks after exposure to the virus and include headache, backache, vomiting and fever. As the fever subsides, red spots appear on the face and spread to the rest of the body. In the following days the spots change into pus-filled blisters, which eventually develop into scabs. Two to three weeks later the scabs fall off, leaving permanent scars in most cases. The patient is infectious until all the scabs have been shed. The virus usually remains in the body for about five weeks. See: *Concise Medical Dictionary* (Oxford 2010).

9 F. Fenner et al., *Smallpox and its eradication* (Geneva 1988) 201-215.

10 D. Hopkins, *The greatest killer: Smallpox in history* (Chicago 2002) 3; W. Rutten, *De vreselijkste aller harpijen: pokkenepidemieën en pokkenbestrijding in Nederland in de achttiende en negentiende eeuw: een sociaal-historisch en historisch-demografische studie* (Wageningen 1997) 23-24.

11 Inoculation or variolation is the deliberate introduction of the smallpox virus into the skin, with pus or scabs taken from a patient, in the hope that a mild infection will develop and induce immunity.



*Illustration 1* Painting showing a doctor performing smallpox vaccination on children. The bust on the pedestal is that of Edward Jenner (1749-1823), an English rural physician who is considered the pioneer of the smallpox vaccine. The grisaille painting above the door refers to the primary source of the vaccine, cowpox pus (source: Jean Baptiste Maes (Ghent 1794- Rome 1856), Smallpox vaccination. City Museum Ghent STAM).

tion campaigns in the early 1800s. These proved to be much more effective than inoculation, and the systematic implementation of smallpox immunization throughout the nineteenth and twentieth centuries culminated in its global eradication in 1979. Today, it is still the only human disease eradicated by vaccination.<sup>12</sup>

Although the survivors of a smallpox attack usually had lifelong immunity to the disease, there were possible side effects. Most survivors had permanent scars (pockmarks), primarily on the face, but some also suffered from more serious complications, such as pneumonia. Medical research has shown other long-term effects, such as blindness and limb deformation.<sup>13</sup> Historical research, moreover, has pointed to the

<sup>12</sup> P. Razzell, *The conquest of smallpox. The impact of inoculation on smallpox mortality on eighteenth century Britain* (Sussex 2003); P. Sköld, *Two faces of smallpox: A disease and its prevention in eighteenth and nineteenth century Sweden* (Umea 1996).

<sup>13</sup> Some state that the disease can result in female infertility, but evidence is scarce. A.R. Rao, 'Pregnan-

influence of smallpox on height. In an article from 1996, two economic historians, Hans-Joachim Voth and Timothy Leunig, claimed on the basis of historical evidence that the disease had a strong negative impact on the average height of survivors.<sup>14</sup> Using source material from nineteenth-century England, they concluded that smallpox reduced attained height by at least 1 inch (or 2.54 cm). Moreover, since smallpox declined strongly during the nineteenth century, they claimed that a substantial part of the increase in people's height during the nineteenth century was due to the eradication of smallpox.

These new findings gained a lot of attention and gave rise to a heated debate between Voth and Leunig on the one hand, and Mark Heintel, Jörg Baten, Peter Razzell and Deborah Oxley on the other. Their comments and discussions resulted in nine articles, all published in the *Economic History Review* between 1996 and 2006.<sup>15</sup> Voth and Leunig's source material, as well as their methodology, were called into serious question. Their sources were the nineteenth-century registers of the Marine Society; the setting was nineteenth-century London, although Oxley extended the analyses across Britain and Ireland by using prison registers and indents of transported convicts. Still, after a decade of debate, the dispute over the smallpox effect remains unresolved. In this article, we focus on the small Belgian town of Thielt in the early nineteenth century and bring some new evidence to the debate by introducing two new sources: military lists and lists of smallpox patients. As we will show, using these sources offers some particular advantages.

In the first section of this article, we present the current state of the debate on the effect of smallpox on height. Starting with Voth and Le-

cy and smallpox', *Journal of the Indian Medical Association* 40:8 (1963) 353-363; A.M. Phadke, 'Smallpox as an etiological factor in male fertility', *Fertility and Sterility* 24 (1973) 802-804; Razzell, *The conquest of smallpox*, 109-110, 156-157; A.W. Crosby, 'Smallpox', in: K. Kiple (ed.), *The Cambridge world history of human disease* (Cambridge 1993) 1009; Rutten, *De vreselijkste aller harpijen*, 145-146.

14 H.J. Voth and T. Leunig, 'Did smallpox reduce height? Stature and the standard of living in London, 1770-1873', *Economic History Review* 49:3 (1996) 541-560.

15 P. Razzell, 'Did smallpox reduce height?', *Economic History Review* 51:2 (1998) 351-359; M. Heintel and J. Baten, 'Smallpox and nutritional status in England, 1770-1873: On the difficulties of estimating historical heights', *Economic History Review* 51:2 (1998) 360-371; T. Leunig and H.J. Voth, 'Smallpox did reduce height: A reply to our critics', *Economic History Review* 51:2 (1998) 371-381; P. Razzell, 'Did smallpox reduce height? A final comment', *Economic History Review* 54:1 (2001) 108-109; T. Leunig and H.J. Voth, 'Smallpox really did reduce height: A reply to Razzell', *Economic History Review* 54:1 (2001) 110-114; D. Oxley, '“The seat of death and terror”: Urbanization, stunting and smallpox', *Economic History Review* 56:3 (2003) 623-656; T. Leunig and H.J. Voth, 'Comment on “Seat of death and terror”', *Economic History Review* 56:3 (2006) 607-616; D. Oxley, '“Pitted but not pitied” or, does smallpox make you small?', *Economic History Review* 59:3 (2006) 617-635.

unig's study, we discuss the different criticisms and comments by looking at the sources and methods used. The research of Oxley figures prominently in this debate and is addressed accordingly. The main body of this article consists of an analysis of the relationship between height and smallpox in Thielt. The town, the sources and the sample used are described in detail in section two. Section three presents the main results: we start with several bivariate analyses and end with a multivariate model. We conclude the article by discussing the implications of our work for the smallpox debate in particular, and historical anthropometry and morbidity in general.

## The current state of the debate

The debate on the effect of smallpox was instigated in 1996 by an article by Hans-Joachim Voth and Timothy Leunig (see table 1).<sup>16</sup> Using the records of circa 26,000 boys accepted into the British Marine Society in the years 1770-1873, they compared the height of boys who had been infected with smallpox with those who had not.<sup>17</sup> The Marine Society was a charitable institution that recruited poor London boys (aged 13 to 17) to train them as servants for the navy. Apart from their age, place of origin, and the ability to read and write, the institution also registered the health and height of each recruit. Since recruitment officers wanted to inspect the boys' resistance to diseases, they recorded whether the teenagers had survived smallpox. Likewise, stature was considered an indication of physical strength, which is the reason why the Marine Society required a minimum height. Consequently, short people were systematically underrepresented in Voth and Leunig's data sample (in statistics, this is known as 'left-hand truncation'). This bias was overcome by using the mode as a measure of central tendency, since it is not influenced by the tails of a distribution. The comparison of the two population groups revealed a strong difference in mode: the modal boy who had suffered from smallpox was in general 3 inches shorter (7.62 cm) than those who had not. However, since their data spans a period of more than a century, the difference may simply be the result of changes

16 H.J. Voth and T. Leunig, 'Did smallpox reduce height? Stature and the standard of living in London, 1770-1873'.

17 Voth and Leunig were able to use part of the dataset of Floud, Wachter and Gregory (*Height, Health and History*, 1993), gathered to reconstruct the evolution of heights of the British population from 1750 to 1980.

in living standards. The boys who had suffered from smallpox may have been shorter not only because they had survived the disease, but also because they were born earlier, and as such experienced a lower standard of living. Voth and Leunig used two methods to circumvent this problem. First, a time series regression including a real wage index was estimated. Secondly, a cross-sectional regression was performed for the period between 1770 and 1775, when smallpox was at its peak. By using a short time frame, they avoided large variations in living standards, as well as changes in height requirements at recruitment. The cross-sectional analysis suggested that smallpox had a smaller effect on attained height than the time series analysis (0.5 inch vs. 1 inch). Still, both analyses showed that smallpox had a significant negative effect on height.

Some scholars, however, were not convinced. Peter Razzell, an expert in the history of smallpox, pointed to major problems with the data used by Voth and Leunig.<sup>18</sup> According to Razzell, smallpox was not adequately recorded in the registers of the Marine Society. This was clear from the chronological pattern of smallpox incidence in the recruits, which was inconsistent with other studies on smallpox in late eighteenth- and nineteenth-century London. Voth and Leunig's data showed a sharp rise in smallpox incidence for boys born in the 1750s and an incidence of nearly 100 per cent between 1760 and 1820, followed by a sudden absence in the 1830s. However, there was no evidence in other sources that could confirm such a strong pattern. Razzell claimed that this inconsistency was related to registration and coding problems in the original Marine Society sources. Since Voth and Leunig had only worked with computerized datasets and not the original source material, they were not aware of the fact that blank entries regarding smallpox may have been coded as 'no smallpox', rather than 'unknown'. In fact, the Marine Society ceased to register smallpox from 1844 onwards. Furthermore, the registration of smallpox in the registers included not only boys who had suffered from smallpox in its natural form, but also those who had only contracted the disease in its inoculated form. According to Razzell, contemporaries viewed inoculation as a type of smallpox, believing it was just another form of the disease. As the Marine Society was interested in the question of whether boys were vulnerable to smallpox when it sent them to the navy, they asked them whether they had previously had smallpox, either in its natural or inoculated form – since both were preventive measures against the disease. This

18 P. Razzell, 'Did smallpox reduce height?'; P. Razzell, 'Did smallpox reduce height? A final comment'.

explains, according to Razzell, why the data from the Marine Society is not consistent with historical scholarship on smallpox and inoculation in London, and more importantly, 'why the issue of the impact of smallpox on attained height cannot be settled by analysis of the Marine Society dataset'.<sup>19</sup> Voth and Leunig replied to his criticism in two separate articles.<sup>20</sup> While they did not dispute the fact that their dataset contained some errors and that there was no registration of smallpox after 1844, they claimed that potential miscoding made no difference to the final result. They replied with two new analyses: one in which they restricted their analyses to literate boys,<sup>21</sup> and another focusing on particular years (1777-1778) for which they believed the registration of smallpox was of high quality. Both studies confirmed previous analyses. Voth and Leunig concluded, once again, that smallpox results in stunting.

Whereas Razzell questioned Voth and Leunig's sources, Markus Heintel and Jörg Baten, two German economic historians, focused on their methodology.<sup>22</sup> They stated that Voth and Leunig had introduced 'an artificial impact of smallpox on height' by not taking sample biases into account.<sup>23</sup> Since the samples were affected by left- and right-hand truncation (too few short and tall people), Voth and Leunig should have used smoothing techniques (such as the kernel density estimators) before calculating the mode. Moreover, the fact that the Marine Society changed the height requirements several times throughout the century implies that time series regression should not have been applied. For this reason, Heintel and Baten divided the 103-year period into seven equal subsamples, applied a kernel density estimator to each of them and compared the heights of those who had contracted smallpox with those who had not. Their analysis revealed that Voth and Leunig's cross-sectional analysis for the 1770-1775 subsample was unrepresentative, and that they had disregarded all the periods in which their hypothesis was not confirmed. Voth and Leunig reacted to these allegations by stating that smoothing techniques were unnecessary, since the tails of the distribution had no influence on the outcome. Moreover, while Heintel

19 Razzell, 'Did smallpox reduce height? A final comment', 109.

20 T. Leunig and H.J. Voth, 'Smallpox did reduce height: A reply to our critics'; T. Leunig and H.J. Voth, 'Smallpox really did reduce height: A reply to Razzell'.

21 The Marine Society registers are difficult to use since the forms do not have separate columns for literacy and smallpox, but just one column with a composite heading 'reads or writes/spox'. So by focusing on the literate, state Voth and Leunig, genuine cases of 'no smallpox' can be identified.

22 M. Heintel and J. Baten, 'Smallpox and nutritional status in England'.

23 *Ibidem*, 367.

**Table 1** Historiographical overview of the smallpox effect on height

	Sources and sample	Methods	Smallpox evidence	Location
Voth & Leunig (1996)	Marine Society registers: c. 26,000 recruits (1770-1873)	Descriptive statistics (mode); time series regression (1770-1873); cross-sectional regression (1770-75)	Smallpox history by recruit	London
Razzell (1998)	Dataset Voth & Leunig	Re-examination of archival source	Smallpox history by recruit	London
Heintel & Baten (1998)	Dataset Voth & Leunig	Smoothing techniques; time series analysis	Smallpox history by recruit	London
Voth & Leunig (1998)	Dataset Voth & Leunig; Sub-sample of literate recruits	Time series regression (1770-1873); cross-sectional regression (1770-75)	Smallpox history by recruit	London
Voth & Leunig (2001)	Dataset Voth & Leunig; Sub-sample of literate recruits	Time series regression (1770-1873) divided into sub-periods	Smallpox history by recruit	London
Razzell (2001)	Dataset Voth & Leunig	Re-examination of archival source	Smallpox history by recruit	London
Oxley (2003)	Prison and convict registers: c. 11,500 convicts (1831-35) and c. 4,700 prisoners (1866)	Descriptive statistics (average); cross-sectional regression	Registration of pockmarks by administrators	England (urban, rural, London)
Voth & Leunig (2006)	Dataset Oxley	Meta-analysis	Registration of pockmarks by administrators	England
Oxley (2006)	Dataset Oxley + c. 19,000 transportees (1831-38) and 33,000 prisoners (1858-60, 1866, 1877-78)	Descriptive statistics (average); cross-sectional regression	Registration of pockmarks by administrators	England Ireland
Vervaeke & Devos (2017)	Register of smallpox patients (1839) linked with military lists (1839-59): c. 850 children and adolescents	Descriptive statistics (mode, median, average); cross-sectional regression	Medical register of smallpox patients	Town of Thielt, Belgium

and Baten accused them of not taking into account changing height requirements, it appeared that the former had also ignored the issue: minimum height was not constant in most of their own subsamples. In addition, four of the seven samples consisted of less than 30 observations. As a result, Voth and Leunig firmly reasserted their position.

In 2003, Deborah Oxley added new elements to the discussion by analysing other source materials (see table 1).<sup>24</sup> Information on height and smallpox in the early 1830s was collected from London prison records and registers of convicts transported to Australia. Prison clerks registered physical characteristics for the purposes of identification, rather than as an indicator of physical strength. Unlike the Marine Society registers, smallpox history was not based on personal statements made by the prisoner himself, but on an examination by the administrators by means of a visual inspection for pockmarks. Another important advantage of this type of source is that the registers include people across Britain and Ireland. Since the debate had up until then focused on Londoners, information on place of birth permitted an extended geographical analysis. Consequently, Oxley performed her analyses on c. 11,500 English- and Irish-born prisoners. Using a regression model, she showed that there was a marked relationship between smallpox and height. Yet, the effect was only visible for London. Pockmarked Londoners were significantly shorter (almost 0.5 inch) than people in the rest of the country. In small cities, the effect was present but negligible, and in the countryside it was barely detectable. Still, the question was not settled. In fact, Oxley argued that smallpox was acting as a proxy for another determinant of height, namely urbanization. As smallpox was transmitted by direct human contact, living in a crowded environment was an important risk factor for smallpox infection. In other words, stunting was not caused by variola, but by crowding, and should therefore be considered a health penalty of urban life.

Voth and Leunig, in a comment on Oxley's research, claimed that the absence of a smallpox effect in areas outside London was mainly caused by the fact that the dataset had been subdivided into small (regional) samples.<sup>25</sup> Small sample sizes generally lead to statistically insignificant results. When the different samples are combined in a meta-analysis, Voth and Leunig argued, the results show that smallpox did reduce height, irrespective of location. Furthermore, they claimed that pock-

24 Oxley, "The seat of death and terror": Urbanization, stunting and smallpox'.

25 T. Leunig and H.J. Voth, 'Comment on "Seat of death and terror"'.

marks are not necessarily a good proxy for smallpox, since a third of smallpox survivors did not have visible pockmarks. So a large percentage of the healthy people in Oxley's dataset could have been classified incorrectly. Voth and Leunig called for an increase in sample size, and in response, Oxley published a second article, this time with an even larger dataset, containing more than double the number of prisoners and convicts.<sup>26</sup> However, once again, her analysis showed that the results were not replicable across place, and that smallpox did not necessarily make people shorter. Nevertheless, Oxley cautioned against oversimplification and argued that the urbanization hypothesis could be flawed as well, since the prisoners probably came from underprivileged areas and were thus more prone to malnutrition and ill-health. Oxley hereby warned against potential data bias and argued for samples that allow for the capture of compositional effects, an issue which is clearly addressed in our study of Thielt.

## The town of Thielt: context, sources and sample

In this article, we focus on a cohort of 19 and 20-year-old young men, born between 1820 and 1839, in the Belgian town of Thielt. Thielt is located in the west of Flanders, in the middle of the triangle formed by the cities of Bruges, Ghent and Kortrijk. At the time of the first Belgian census in December 1846, the town had approximately 12,000 inhabitants.<sup>27</sup> As a small rural town in Belgium, it provides an excellent opportunity to study Voth and Leunig's claim that smallpox resulted in stunting, irrespective of location.

### *Context*

During the Late Middle Ages and early modern period, Thielt developed as an important regional trade centre based on agriculture and local industries, particularly textiles. Thielt built a cloth hall as early as the late thirteenth century and a century later it was organizing annual fairs. However, it was mainly the thriving linen industry in the eighteenth century which brought prosperity to the town. This export-oriented industry had developed in the Flemish countryside to complement agricul-

<sup>26</sup> Oxley, "Pitted but not pitied" or, does smallpox make you small?"

<sup>27</sup> Data provided by LOKSTAT (Historical Database of Local Statistics), supervised by Eric Vanhaute and Sven Vrielinck, Quetelet Center, Ghent University.

tural production on small farms. More than other Flemish towns, Thielt flourished as a marketplace for traders and weavers from the region.<sup>28</sup> By the early nineteenth century, more than a third of the male heads of households in Thielt were involved in linen production. In the villages around the town, this could rise to more than 50 per cent. Besides day labourers, records show that about 20 per cent of the town's inhabitants were involved in agriculture, 15 per cent in crafts, 10 per cent in administration and 8 per cent in trade and transport.<sup>29</sup> This was also the period when the town was renowned for its many gin distilleries.

By the early 1830s, however, there was a reversal of fortune as the demand for handmade rural linen fell rapidly due to rising competition from inexpensive mechanized British cotton. On top of this structural crisis came a series of harvest failures in the late 1840s, affecting potato and cereal crops, which led to a collapse in living standards for many segments of the Flemish population. Thielt, positioned in the heart of the linen region, was badly hit. Real wages in the town halved compared to a century earlier.<sup>30</sup> At the peak of the crisis, in 1846-47, nearly 30 per cent of Thielt's population relied on poor relief.<sup>31</sup> This is also reflected in the birth rates, which declined to just above 20 per thousand, compared to 30 per thousand in the rest of West Flanders and 35 per thousand in Thielt in the 1830s.<sup>32</sup> Death rates rose to 37 per thousand, due to epidemics such as typhus in 1846-47 and cholera in 1854. Smallpox, however, did not claim any victims in Thielt during these particular crisis years.<sup>33</sup>

### Sources

Thielt is a highly relevant case study for the smallpox debate because, besides its small size and location outside England, it also offers rich source materials. Historical sources in which height as well as smallpox were recorded are extremely rare. In this study we make use of smallpox registers and military listings. By combining the two sources available for Thielt, we present a unique insight into the possible effect of small-

28 M. Cloet, L. Daels, J. Decavele, *De geschiedenis van Tielt. Een nieuwe kijk op het verleden* (Tielt 2000).

29 Data provided by STREAM (Spatiotemporal Research Infrastructure for Early Modern Flanders and Brabant), supervised by Isabelle Devos, Quetelet Center, Ghent University.

30 C. Vaneekhaute, *Levensstandaard en tewerkstelling in Tielt 1700-1900* (Ghent University History Department, LIC dissertation 1982) 369-376.

31 E. Strobbe, *Micro-onderzoek over social economische mutaties in de stad Tielt, 1830-1860* (Ghent University History Department, MA dissertation 1982) 407.

32 *Ibidem*, 34-41.

33 *Ibidem*, 60-64.

Illustration 2 Patient list during a smallpox outbreak, Thielt, December 1838–November 1839 (source: City Archive Thielt, BE SAT/MAT/07/B/P.B./958c).

pox on height. However, the two sources come with their own set of advantages and drawbacks. We discuss each source separately.

Our first source is a list of smallpox patients in Thielt for the year 1839, when an outbreak of the disease occurred in Belgium (see illustration 2 for a fragment).<sup>34</sup> According to the royal decree of 18 April 1818, it was compulsory for physicians to register all smallpox patients in the case of an epidemic. Unfortunately, few registers have been preserved. In Thielt, the register mentions a.o. the date of the diagnosis, the name, age and sex of the patient, and whether or not he or she was vaccinated, and died of the disease. The first smallpox patient during the epidemic surge was registered in December 1838 and the last one in December 1839. During that year, 852 people or about 7 per cent of the population were diagnosed with the disease. A little under 4 per cent of the total number of patients (32 people) died, mainly small children.<sup>35</sup> The upsurge in Thielt was thus rather modest. The moderate prevalence and case-fatality rate was probably related to the fact that vaccination was widespread at the time.<sup>36</sup> According to the Thielt list, 63 per cent of the inhabitants had been vaccinated.

34 City Archive Thielt, Modern Archive, BE SAT/MAT/07/B/P.B./958c, Briefwisseling en stukken betreffende de pokken en de inenting er tegen, 1832-1942.

35 For comparison, 10 per cent of the population in Nijkerk, a small village in the Netherlands, was struck by an outbreak of smallpox between 1870 and 1873. Overall, 20 per cent of the victims did not survive. Other research has shown that smallpox mortality could be as high as 30 per cent. Rutten, *De vreselijkste aller harpijen*, 24, 151-153.

36 G. Gadeyne, 'Variolatie en vaccinatie tegen de pokken in België sinds de 18de eeuw', *Geschiedenis der Geneeskunde* 6 (2000) 364-375.

The list of smallpox patients mentions per patient: last name, first name, age, sex, date of appearance of the disease, date of cure, date of death, date of vaccination if the subject was vaccinated, whether the disease was benign or malignant, whether the patient was disfigured or disabled because of the disease, and other remarks (in most cases: name of the street where the patient lived).

Some typical characteristics of smallpox are apparent in the Thielt epidemic. Firstly, many children suffered from the disease: 40 per cent of the smallpox patients were under the age of ten. This is much less than the 80 per cent according to the medical literature,<sup>37</sup> which could be due to the large-scale vaccination of young children. Still, our data for Thielt indicate that 67 per cent of the patients below the age of ten were not protected, and as such were the primary victims of the disease. We assume that the lower percentage of smallpox among Thielt children in 1839 is mainly the result of two processes. On the one hand, a high percentage of smallpox among adults who, despite being vaccinated, became infected again as a result of neglecting revaccination, a necessary measure that physicians started to implement by the 1860s.<sup>38</sup> On the other hand, the authorities adopted a less stringent vaccination policy. In the early nineteenth century, most parents followed central governmental rules: young children were vaccinated as soon as possible.<sup>39</sup> This compliance, however, strongly declined in the 1830s when the new Belgian government transferred responsibility for vaccination control to provincial and municipal authorities. Moreover, vaccination as a preventive measure came under question, as an increasing number of vaccinated people were falling prey to the disease.<sup>40</sup>

Secondly, smallpox victims in Thielt usually went through a brief but intense period of illness. In this case, the average duration of the disease was 18 days, somewhat less than the 21 days described in the medical literature. Most patients recovered fast, but some remained sick for nearly half a year. Collette Schokele, for instance, was sick for 180 days.

37 Crosby, 'Smallpox', 1010; Oxley, '“The seat of death and terror”', 626.

38 According to Rutten, revaccination was necessary to keep up immunity levels. Rutten, *De vreselijkste aller harpijen*, 152.

39 Rutten, *De vreselijkste aller harpijen*, 44-49; 'n<sup>o</sup>20 Besluit van den 18den April 1818 houdende bepalingen ter bevordering van het meer algemeen gebruik der koepok-inenting', in: *Staatsblad van het Koninkrijk der Nederlanden 1818* (The Hague 1818).

40 Gadeyne, 'Variolatie en vaccinatie'; M. Van den Abeele, *De pokken in Oost-Vlaanderen in de periode 1815-1840* (Ghent University History Department, MA dissertation 2006), 122.

Although our register suggests that she suffered from smallpox during this entire period, secondary ailments prolonged her illness.<sup>41</sup>

One of the main issues in the smallpox debate has been the quality of smallpox registration in the source materials. In our study, the smallpox records are not based on a person's own statements about their medical history, nor on visual pockmarks, but on the registration of a smallpox infection by a physician at the time of the outbreak. However, we cannot be sure that those who were not registered on the 1839 list had not suffered from smallpox before, particularly since exposure to the disease usually confers lifetime protection. Still, an analysis of the epidemiological environment of Thielt since the 1820s reveals only a few rare cases of smallpox and no particular surges.<sup>42</sup> This is not surprising, since intervals between outbreaks could easily last many years. A lower population density and fewer new inhabitants (children or migrants) could reduce the risk of an outbreak.<sup>43</sup> Furthermore, taking into account that most people were vaccinated against smallpox, the probability that our subjects had previously been diagnosed with smallpox is extremely small.

Military listings are the most common historical source of evidence on height and constitute the second source for our analysis. For this study on Thielt, we combined the 1839 smallpox list with conscription lists for the years 1839 to 1859. The French administration had introduced military conscription in 1789, and since then every male aged 19 (and after 1849 aged 20) had been required to register for military service. The military registers of Thielt include the name of the conscript, his profession as well as that of his father and/or mother, the place and date of birth, place of residence and physical features such as height.<sup>44</sup> Apart from this detailed individual information, military registers offer other advantages as well. While prisoners, convicts and marine recruits were likely to come from more deprived social backgrounds, disadvantaged groups are not overrepresented in conscription lists. Military recruit-

41 City Archive Thielt, Modern Archive, BE SAT/MAT/07/B/P.B./958c, Briefwisseling en stukken betreffende de pokken en de inenting er tegen, 1832-1942.

42 A. Vervaeke, *Tussen letsels, latten en lakens. De invloed van pokken op de gezondheid. Een onderzoek naar lichaamslengte en vruchtbaarheid in het begin van de negentiende eeuw* (Ghent University History Department, MA dissertation 2012).

43 Rutten, *De vreselijkste aller harpijen*, 101-102.

44 City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B./762, inschrijvingsregister 1834-1844; BE SAT/MAT/04/D/P.B./763, inschrijvingsregisters, 1845-1856; BE SAT/MAT/04/D/P.B./764, inschrijvingsregisters, 1857-1866.

ment was also subject to a height limit, yet the height of every potential recruit was registered, since conscription was mandatory. As a result, we have information for all populations, poor and wealthy, short and tall. This allows us to perform a varied and nuanced analysis of the relationship between height and smallpox. Still, a common downside of military samples is the fact that the conscripts are not fully grown at the time of recruitment (ages 19-20). However, for our study, this bias is actually an advantage. The smallpox effect was deemed more pronounced in young people compared to adults, since the latter might have recovered from the arrested growth (catch-up growth).<sup>45</sup>

**Table 2** Number of smallpox survivors linked to military registers

Birth cohorts	Military cohorts	Number of smallpox survivors (0-19 years) according to 1839 register	Number of smallpox survivors traced in military lists (1839-1859)	Percentage linked
1820-24	1839-43	48	43	89.6%
1825-29	1844-49	74	67	90.5%
1830-34	1850-54	79	56	70.9%
1835-39	1855-59	93	49	52.7%
<b>Total</b>		<b>294</b>	<b>215</b>	<b>73.1%</b>

Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

Since we were examining the population of a small town, we could easily link the survivors listed in the 1839 smallpox register with the young men in the military registers. Smallpox mostly infected children and adolescents and we are interested in its impact on height, so we searched for the heights of smallpox survivors, who had been aged 0-19 in 1839, in the Thielt military registers for the period 1839-1859 (see table 2).<sup>46</sup> However, we were unable to track down 27 per cent of the boys in the military documents, either because they had moved outside Thielt or because they had died between the outbreak of 1839 and the time they would have been registered as a conscript. Nevertheless, as table 2 shows, we were still able to trace 215 smallpox survivors. For some, however, there is no indication of height. This left us with a sample of 207 men, only a fraction of the sample sizes in the studies of Oxley, Voth and

<sup>45</sup> T. Leunig and H.J. Voth, 'Comment on "Seat of death and terror"', 615.

<sup>46</sup> City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B./762, Inschrijvingsregister 1834-1844; BE SAT/MAT/04/D/P.B./763 Inschrijvingsregisters, 1845-1856; BE SAT/MAT/04/D/P.B./764 Inschrijvingsregisters, 1857-1866.

Leunig. However, although their studies start with an impressive number of observations (more than 25,000), the core of their arguments are based on subsamples of less than a hundred persons. In fact, sample size has been an important topic of discussion in the smallpox debate, and in that sense our study is not an exception. Notwithstanding sample size, our study raises another important issue: that of sample composition. By linking the two sources, our analysis allows for a more detailed study of the subjects that takes into account their individual and familial attributes, such as whether the father was still alive, and if so, the father's occupation. As height is strongly influenced by living conditions during childhood, information on family background is of essential importance.

To sum up, this article on Thielt presents an original case study in the smallpox debate for at least four main reasons. First, the smallpox information in the Thielt sources is based on a physician registering details at the time of an outbreak, instead of visual scars recorded by an administrator or personal statements by a former patient. Secondly, the military sources provide data on the household circumstances of our subjects, allowing insights into childhood conditions and possible compositional effects. Thirdly, the young men were measured at ages 19-20, an age at which, on the one hand, catch-up growth is supposed to be less pronounced than in adults, and on the other hand the smallpox effect on height is supposed to be more pronounced than in the 13-17-year-old boys examined in the British studies. Finally, whereas the smallpox debate has focused exclusively on the British case, and on London in particular, we study a rural town in Belgium, allowing one to discuss Voth and Leunig's thesis that smallpox reduced height, regardless of location.

### *Sample*

In order to determine the effect of smallpox, we compare two groups in this study, one consisting of smallpox survivors, and the other of young men who presumably had not suffered from the disease. This control group was randomly selected from young men in the military registers for whom height, place and date of birth, place of residence and most household characteristics were registered, and who – obviously – were not listed as smallpox patients in the 1839 smallpox register. Together with the 207 smallpox survivors, the entire sample for this study consists of 851 young men, who were born in Thielt between 1820 and 1839, and raised there between 1820 and 1859.

However, one problem related to the composition of the smallpox group remains. As stated earlier, the smallpox registers mention whether or not the victims were vaccinated. Since 63 per cent were artificially protected, a possible smallpox effect could have been mitigated, since vaccination reduces the severity of the infection. To exclude possibly contaminated results, the relationship between vaccination and the duration of the disease was investigated (table 3). Information about the vaccination history and disease duration is available for 711 persons. The numbers indicate that those who were vaccinated went through a shorter period of illness. About 80 per cent recovered within a month, compared to only 70 per cent of the unvaccinated individuals. However, most patients had recovered within two months.

**Table 3 Duration of the smallpox infection for vaccinated and unvaccinated populations in Thielt**

Duration	Vaccinated	Not vaccinated
< 10 days	214 (48%)	79 (30%)
10-19 days	114 (26%)	76 (29%)
20-29 days	29 (7%)	29 (11%)
1-2 months	64 (14%)	66 (25%)
> 2 months	25 (5%)	15 (5%)
<b>Total</b>	<b>446 (100%)</b>	<b>265 (100%)</b>

Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

Although vaccinated patients suffered from a milder form of smallpox than non-vaccinated ones, the difference between these groups is rather small. The fact that our smallpox group consists of vaccinated as well as unvaccinated patients does not affect the height outcome, since most of the patients suffered from the disease for fewer than twenty days.

## Smallpox and heights in Thielt, 1820-1859

### *Smallpox*

Looking at the relationship between smallpox and height, table 4 seems to confirm the smallpox effect. The mean as well as the median height of smallpox survivors is the lowest. Smallpox survivors were on average 1.1 cm shorter than young men who had not suffered from the disease. Obviously, considering the small sample size, the results must be inter-

puted with care. Therefore, it is also important to take into account the confidence intervals.

**Table 4 Heights of smallpox survivors vs. those with no smallpox, Thielt birth cohorts (1820-1839)**

Birth cohorts (1820-1839)	Smallpox	No Smallpox	Total
Mean height	160.0 cm	161.1 cm	160.8 cm
Confidence intervals (95%) min. height	158.8 cm	160.5 cm	160.3 cm
Confidence intervals (95%) max. height	161.2 cm	161.8 cm	161.5 cm
Median height	160.0 cm	162.0 cm	162.0 cm
Modal height	160.0 cm	162.0 cm	157.0 cm
Min. height	137.5 cm	126.0 cm	126.0 cm
Max. height	183.5 cm	183.0 cm	183.5 cm
Standard deviation	8.776 cm	8.765 cm	8.776
N	207	644	851
Difference in mean compared to smallpox survivors		+ 1.12 cm	+ 0.84 cm

Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

However, without examining these groups in more detail, we cannot be certain about the effect of smallpox. If stunting was due to smallpox, then the impact of the disease should have been largely similar, irrespective of location and childhood circumstances. Fortunately, the military registers give us some background information on the young men in our sample. For instance, we know whether the father was alive at the time of conscription, and if so, his occupation. These variables allow one to gain an insight into socio-economic conditions during childhood and adolescence. We first examine the two variables separately and then analyse them simultaneously.

### *Father's death*

Our analysis of the Thielt registers reveals that about 31 per cent of the young men lost their father during their childhood (table 5). Yet we have no indication as to exactly when the father died, so it may have been during infancy, early childhood or adolescence. The effects of parental death, particularly that of the father, is a well-studied topic in historical demography and economic history. Studies generally point to a negative impact, resulting in economic stress, and higher infant and child mor-

**Table 5 Smallpox effect linked to presence of the father, Thielt birth cohorts (1820-1839)**

Birth cohorts (1820-1839)	Smallpox	No Smallpox	Total
<b>Father alive</b>			
Mean height	160.6 cm	161.8 cm	161.5 cm
Confidence intervals (95%) min. height	159.1 cm	161.0 cm	160.8 cm
Confidence intervals (95%) max. height	162.0 cm	162.6 cm	162.2 cm
Median height	161.0 cm	162.0 cm	162.0 cm
N	148	434	582
Difference in mean compared to smallpox survivors		+ 1.26 cm	+1.06 cm
<b>Father deceased</b>			
Mean height	158.6 cm	159.7 cm	159.5 cm
Confidence intervals (95%) min. height	156.6 cm	158.4 cm	158.3 cm
Confidence intervals (95%) max. height	160.8 cm	160.9 cm	160.6 cm
Median height	160.0 cm	161.0 cm	160.0 cm
N	59	210	269
Difference in mean compared to smallpox survivors		+ 1.05 cm	+ 0.90 cm

Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

tality.<sup>47</sup> The child's chances of marriage and migration also appear to be affected, although this is largely dependent on the sex and birth order of the child in the family.<sup>48</sup> Recently, the impact of the father's death has also been addressed in anthropometric studies. For instance, research into nineteenth-century England by Horrell and Oxley has revealed that in families where the mother was the main (or only) breadwinner, household resources such as nutrition and medical care were more limited, and as a result children were generally smaller.<sup>49</sup> In early nine-

47 R. Derosas and M. Oris (eds.), *When dad died: Individuals and families. Coping with family stress in past societies* (Bern 2002); S. Horrell, J. Humphries and H.-J. Voth, 'Destined for deprivation: Human capital formation and intergenerational poverty in nineteenth-century England', *Explorations in Economic History* 38 (2001) 339-365.

48 S. De Langhe, *Oude vrijsters. Bestaansstrategieën van ongehuwde vrouwen op het Brugse platteland, late achttiende-begin negentiende eeuw* (Ghent University History Department, PhD dissertation 2013); G. Alter, *Family and the female life course* (Madison 1988) 127-129; Alain Lottin, 'Naissances illégitimes et filles-mères à Lille au xviii<sup>e</sup> siècle', *Revue d'histoire moderne et contemporaine* 17 (1970) 305-309.

49 S. Horrell and D. Oxley, 'Bargaining for basics? Inferring decision making in nineteenth-century British households from expenditure, diet, stature, and death', *European Review of Economic History* 17:2 (2013) 147-170.

teenth-century Thielt, young men from one-parent families were also clearly shorter than those from two-parent families, on average about 2 cm. Again, the results confirm the smallpox effect. Smallpox survivors from families where the father was still alive, as well as those where the father had died, were shorter than their non-smallpox counterparts.

### *Father's occupation*

Anthropometric research has already shown a strong relationship between the amount (and distribution) of household resources and stature. Families with a larger available income have more resources to invest, can afford more and better nutrition and medical care, and generally speaking have taller children. Obviously, military lists do not give us information about income and spending, but they do mention the profession of the father. At least this was the case for 579 of the 851 Thielt conscripts in our sample. Although far from perfect, we use the father's occupation here as an indicator of the childhood circumstances of our subjects. We categorized the occupations into seven groups: (1) textile and clothing, (2) day labour, (3) agriculture and food industry, (4) trade and transport, (5) crafts, (6) administration and liberal professions, and (7) servants. As our study does not involve any temporal or spatial comparisons, and the occupational diversity in Thielt was rather moderate, we prefer to use the occupational grouping established by De Belder et al. for early nineteenth-century Flemish census data, rather than the well-known HISCO (Historical International Classification of Occupation).<sup>50</sup>

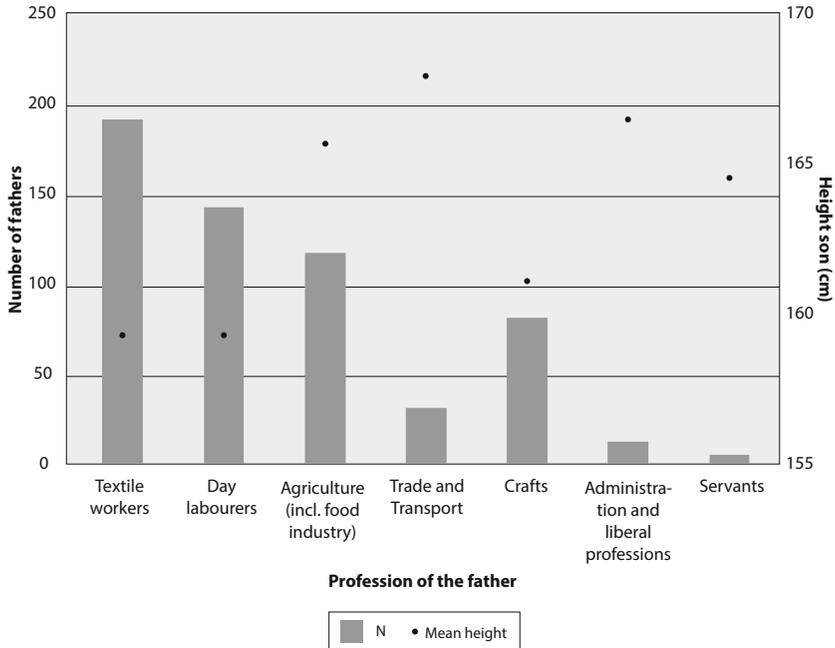
Besides height differences, figure 1 sheds light on the local economy. Although the linen industry was in severe crisis at the time, its importance for Thielt is clearly reflected in figure 1.<sup>51</sup> Looking at the Thielt conscripts, we see for instance that most of their fathers worked in the textile industry, followed by day labour and agriculture.

As for the relationship between the fathers' occupations and sons' heights: it is quite pronounced. In fact, from figure 1, we can distinguish four clusters. First, sons of farmers and those working in the food industry, trade and transport were on average 166 to 168 cm tall. They were on average 6 cm taller than craftsmen, and 8 cm taller than textile workers and day labourers. Their height advantage is quite possibly re-

50 J. De Belder, L. Jaspers and C. Gyssels, *Arbeid en tewerkstelling in West-Vlaanderen 1814-1815: Een socio-professionele en demografische analyse* (Ghent 1984).

51 Cloet, *De geschiedenis van Tielt*, 190-193.

**Figure 1 Average height of conscripts linked to the occupation of the father, Thielt birth cohorts 1820-1839 (n=579)**



Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

lated to easier access to better food supplies (and for farmers in particular to dairy products, since these are known to stimulate height). Secondly, and in contrast, sons of day labourers and men working in the textile and clothing industry were the smallest, on average 159 cm tall. Vandenbroeke, Roosemont and Depauw have observed similar height differences between farmers and labourers for other rural areas in Flanders.<sup>52</sup> Since the linen industry was experiencing a severe crisis at the

<sup>52</sup> In the studies by Vandenbroeke and Roosemont, during the crisis years the differences between farmers and day labourers amounted to almost 5 cm, and up to 7 cm. This is also the case for Depauw's work using prison records, which revealed differences of 3 cm. However, it is important to mention that the three studies were based on the subject's own occupation, and not that of the father. Upward social mobility may thus have reduced the height differences. See: C. Vandenbroeke, 'De keurlingenlijsten als sociaal-demografische bron', *De Leiegouw* (1981) 267; F. Roosemont, 'Sociaal-anthropometrische studie over Oost-Vlaanderen tijdens de eerste helft van de negentiende eeuw aan de hand van militieregisters' (Ghent University History Department LIC dissertation 1981) 25; E. Depauw, 'Grote gangster of klein gespuis? De lichaamslengte in de Gentse gevangenis in de negentiende eeuw', *Handelingen van de Maatschappij voor Geschiedenis en Oudheidkunde te Gent* (2012) 168; E. Depauw, 'Tall farmers and tiny weavers', *TSEG* 14:3 (2017) 56-84.

time, these results are not surprising.<sup>53</sup> Weavers and day labourers were the largest occupational groups, but also the poorest. Figure 1 shows the negative impact on the average heights of sons growing up in such households. Thirdly, the middle cluster consists of craftsmen's sons, who were circa 161 cm tall. Although the crisis also strongly reduced the living standards of the Thielt craftsmen, a study by Vaneekhaute concluded that they suffered less hardship than textile workers and day labourers, but were more vulnerable than the local elite.<sup>54</sup> This middle position is clearly reflected in their height. Finally, the sons of fathers working in administration and the liberal professions appear quite tall. Yet the results are based on only a small number of cases and thus cannot be considered very robust. This is also the case for servants' sons.

If we now focus on the four occupational clusters and examine the smallpox effect for each of them, one finding is immediately apparent from table 6: smallpox did not have a uniformly negative impact on height. In fact, smallpox survivors in the most 'wealthy' group (agriculture, food, trade and transport) were on average taller than the rest of the conscripts. For the other occupations, however, smallpox resulted in stunting. Still, these results might also indicate that smallpox was associated with poverty and that as such the smallpox effect was the result of the poor being overrepresented in our sample. The numbers do indeed show that smallpox targeted the poorer groups in particular. There were clearly more smallpox patients among the working classes: during the 1839 outbreak nearly a third of them fell prey to the virus, compared to less than a fifth of the sons of craftsmen and a seventh of those of farmers and traders (table 6).

Whereas medical research claims that smallpox does not necessarily differentiate between rich and poor,<sup>55</sup> historical evidence points in the opposite direction.<sup>56</sup> In his study on smallpox in the Netherlands, Wil-

53 C. Vandenbroeke, 'Sociale en conjuncturele facetten'.

54 C. Vaneekhaute, *Levensstandaard*, 103, 127, 381-382, 403-404; J. Verbrugge, 'Tielt, Textielstad (Deel 1: negentiende eeuw)', *De Roede van Tielt* 18:2 (1987) 47-53.

55 R. Rotberg and T. Rabb, 'The relationship between nutrition, disease and social conditions: A graphical presentation', in: R. Rotberg and T. Rabb (eds.), *Hunger and history* (Harvard 1985) 308.

56 A. Perrenoud, 'L'inégalité sociale devant la mort à Genève au XVIIe siècle', *Population* 30:1 (1975) 221-243; P.D. 't Hart, *Leven in Utrecht 1850-1914. Groei naar een moderne stad* (Hilversum 2005) 135; P. Sköld, *The two faces of smallpox: A disease and its prevention in eighteenth- and nineteenth-century Sweden* (Umea, 1996) 93-97; P. Darmon, *La longue traque de la variole: les pionniers de la médecine préventive* (Paris 1986) 48-50; P. Razzell, *The conquest of smallpox: The impact of inoculation on smallpox mortality in eighteenth century Britain* (Firle 1977) 150-151. However, Davenport et al. find no evidence for eighteenth century London that smallpox victims were more likely to be poor: Romola Davenport, Leonard

**Table 6 Smallpox effect linked to the occupation of the father, Thielt birth cohorts (1820-1839)**

Birth cohorts (1820-1839)	Agriculture, food, trade and transport		Crafts	
	Smallpox	No smallpox	Smallpox	No smallpox
Mean height	168.0 cm	166.7 cm	159.9 cm	162.0 cm
Confidence intervals (95%) min. height	164.6 cm	165.4 cm	156.2 cm	158.9 cm
Confidence intervals (95%) max. height	171.5 cm	167.9 cm	163.6 cm	163.6 cm
Median height	166.5 cm	166.5 cm	158.5 cm	162.8 cm
Min. height	151.5 cm	151.0 cm	146.0 cm	145.0 cm
Max. height	183.5 cm	183.5 cm	175.5 cm	179.0 cm
Standard deviation	7.802 cm	7.333 cm	8.429 cm	7.632 cm
N	22	129	22	80
Difference in mean compared to smallpox survivors		-1.35 cm		+2.10 cm
Birth cohorts (1820-1839)	Textile. day labourers		Other (liberal professions. etc.)	
	Smallpox	No smallpox	Smallpox	No smallpox
Mean height	159.1 cm	159.2 cm	159.5 cm	167.3 cm
Confidence intervals (95%) min. height	157.4 cm	158.2 cm	51.5 cm	162.8 cm
Confidence intervals (95%) max. height	160.8 cm	160.2 cm	2675 cm	171.7 cm
Median height	159.5 cm	160.0 cm	159.5 cm	169.0 cm
Min. height	137.5 cm	132.5 cm	168.0 cm	141.0 cm
Max. height	181.0 cm	176.5 cm	151.0 cm	182.0 cm
Standard deviation	8.568 cm	7.767 cm	12.021 cm	9.007 cm
N	102	229	2	18
Difference in mean compared to smallpox survivors		+ 0.10 cm		+ 7.75 cm

Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

librord Rutten argues that living conditions were of prime importance for the spread of the disease. For instance, households that could afford a house with multiple rooms were able to isolate a sick family member, and were thus better armed against contagion. Moreover, if there was an outbreak of the disease, they generally had more means to travel to

Schwarz, and Jeremy Boulton, 'The decline of adult smallpox in eighteenth-century London', *Economic History Review* 64:4 (2011) 1289-1314.

a safer place.<sup>57</sup>

In any case, our results suggest that the impact of smallpox on height was not constant, and that other factors might be at play. In fact, just as Oxley stated with regard to her own aggregate analysis: ‘smallpox might have a differential association with height’<sup>58</sup> and might be masking an underlying relationship with (over)crowding. Possibly, the Thielt research points to a similar connection at the micro-level, as overcrowding can enhance the transmission of smallpox at the household level. Even small towns such as Thielt had to deal with crowding, particularly among the working classes.

### *Multivariate analysis*

So far, we have studied each factor potentially affecting height separately: father’s occupation, father’s death and obviously smallpox. For these three variables, clear patterns could be found. The next step is to analyse the relative impact of these factors simultaneously in a multivariate model. As we are dealing with three dependent categorical variables and a continuous independent variable (height), ANOVA is the appropriate statistical method to use here.

At first sight, the results of the multivariate model are in line with those from the cross-tabulations (N=851; Rsquare=0.10;  $F(5,845)=18.705$ ;  $p<0.000$ ). The multivariate model distinguishes between the four occupational clusters. Controlling for the other variables, table 7 shows again that the sons of fathers involved in agriculture, food, trade and transport were on average 5 cm taller than the sons of craftsmen, and 7 cm taller than the sons of textile workers and day labourers ( $p=0.000$ ). The importance of the father is also confirmed by the results on the father’s death. Although we have no information on exactly when the father died, table 7 clearly shows the effect of this death on sons’ heights. Young men whose fathers were still alive when they were 19-20 were on average 7 cm taller than those whose fathers had died by then. The large difference in height is especially noteworthy here. It suggests that in times of economic crisis, as was the case in Thielt during the second quarter of the nineteenth century, the absence of the father was particularly stressful and disastrous. Life for the remaining household members was subject to extreme pressure. The height difference is smallest for sons of ‘other’ occupations, but the results are not significant ( $p=0.91$ ). As men-

<sup>57</sup> Rutten, *De vreselijkste aller harpijen*, 137-143.

<sup>58</sup> Oxley, ‘“Pitted but not pitied” or, does smallpox make you small?’, 617.

**Table 7 Multivariate analysis of the impact of smallpox, father's death and father's occupation on height, Thielt birth cohorts (1820-1839)**

	Unstandardized coefficients		Standardized coefficients Beta	t	Sig.
	B	Std. error			
(Constant)	166.750	.744		224.058	.000
Smallpox (ref. 'no smallpox')	-.488	.673	-.024	-.726	.468
Death of father (ref. 'no death of')	-7.184	.895	-.381	-8.026	.000
Occupation (ref. 'farmers et al.')	-	-	-	-	-
Crafts	-5.091	1.107	-.189	-4.599	.000
Textile and day labourers	-7.415	.872	-.412	-8.506	.000
Other	-.226	2.008	-.004	-.113	.910

Source: City Archive Thielt, Modern Archive, BE SAT/MAT/04/D/P.B.762-764 and BE SAT/MAT/07/P.B./958c.

tioned earlier, this is a very small and heterogeneous group: it concerns fathers employed in administration, liberal professions and service.

Clearly, the fathers' presence and occupations were important for childhood living circumstances, and as such, for sons' heights. More importantly for our study, however, are the results on smallpox. The results in the table are clear: controlled for the death and occupations of the fathers, smallpox does not have any statistically significant effect on the height of the survivors ( $p=0.47$ ). Consequently, our study on Thielt cannot confirm Voth and Leunig's claim that smallpox reduced height.

## Conclusions

Rather than validating height as an indicator of well-being, this article focused on one of the determinants of height, namely disease, and more specifically on Hans-Joachim Voth and Timothy Leunig's controversial thesis that smallpox stunts growth. Voth and Leunig deserve credit for starting the discussion on the impact of disease on growth patterns. They have forced us to think about the relationship between disease, nutrition, environment and the complex interplay of the many factors influencing human growth, which has led to some valuable lessons with regard to the town of Thielt. We can refer to three important issues in particular.

First, the Thielt case emphasizes the importance of micro-level research. Our study, despite (or rather, because of) its small scale allowed

for a different perspective on the smallpox debate by taking into account family attributes and childhood circumstances. It is well-known that aggregate analyses can mask a whole range of underlying relationships. Oxley has already pointed to the association with overcrowding in the English cases. Aggregate analyses usually allow for larger size samples, but sample composition is equally important. Up until now, compositional effects such as the father's occupation have been largely ignored in the smallpox debate. Smallpox does not necessarily differentiate between rich and poor, but the occupational analysis of the smallpox effect in Thielt did suggest a clear divide between the poor and the most privileged populations, possibly explained by other factors such as crowding.

Secondly, a major drawback of rare sources such as the smallpox registers is that they do not usually cover large populations. As a result, it is difficult to obtain statistically significant results. This is a problem, since historical anthropometry has made extensive use of statistical methods. Similarly, much of the smallpox debate has focused on whether the appropriate statistical methods were being used, and whether the assumptions of the techniques were violated or not. Although we agree with Zilliak and McCloskey that statistical significance in historical research should not be followed like a cult, in this particular case (examining a heterogeneous variable such as height) it can be useful to opt for a large sample.<sup>59</sup> However, it is extremely difficult to find individual-level historical sources that give information on height as well as on smallpox, and which simultaneously offer insight into the composition of the sample (individual as well as family attributes), and which are sufficiently large for statistical analysis. Moreover, Peter Razzell has rightly cautioned against an overreliance on statistical evidence, since 'no amount of sophisticated statistical analysis will provide a substitute for careful study of original sources'.<sup>60</sup>

Likewise, no amount of statistical sophistication can rescue an unsubstantiated research question, which brings us to our final and most important point with regard to this special issue. Although infections are generally considered to lower a person's defences, this is not necessarily the case for every infectious disease. According to Oxley, there is no medical argument to support the theory that a short-term and acute

59 S. Zilliak and D. McCloskey, *The cult of statistical significance: How the standard error costs us jobs* (Ann Arbor 2008).

60 Razzell, 'Did smallpox reduce height?', 358.

infection such as smallpox, however deadly, can cause height-reducing effects.<sup>61</sup> Smallpox only lasts for five weeks and does not recur. It does not inhibit nutritional intake, nor is it influenced by a person's nutritional status. In order for it to translate into long-term stunting, infections must be severe and chronic. Gastro-intestinal disorders, such as diarrhoea, are known from extensive medical research to disrupt the growth pattern. Oxley's analysis suggests that the relationship between smallpox and height is rather spurious, in the sense that there is no direct causal connection, but rather an unknown third factor. Oxley has pointed to (over)crowding as the confounding variable, since living in a densely populated setting was a major factor in contracting smallpox. Possibly, the Thielt research points to a similar connection at the household level. In other words, the nature of the relationship – at this point – seems to be environmental, rather than medical.

## About the authors

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61 Oxley, "Pitted but not pitied" or, does smallpox make you small?, 634.