

REGULATION AND THE HEALTH OF CHILD WORKERS IN THE MID-VICTORIAN SILK INDUSTRY

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Introduction

The silk industry of nineteenth-century Britain failed to conform to the pattern of child employment in other branches of textiles, for child labour remained unregulated in the dynamic years of the industrial revolution, allowing the continued employment of comparatively large numbers of children. Two main arguments were persistently advanced by silk manufacturers for special treatment. First, as tariff protection was eroded through the nineteenth century it was imperative to keep labour costs low to combat foreign competition. Second, the silk industry had much healthier working environments than other branches of textiles, and therefore regulation was unnecessary.

This paper will evaluate the second of these arguments. In the first half of the nineteenth century the evidence is primarily from the reports of select committees and factory inspectors; in the second half, the poor conditions associated with factory work were investigated, producing independent evidence of health hazards and working conditions in the form of mortality statistics in the Registrar Generals' reports and industry specific investigations by the Chief Medical Officer of the Privy Council. The data will be used to compare mortality rates in silk manufacturing districts with other textile areas. The primary focus will be on factory employment, since this is where discriminatory regulation occurred. However, it is important to note that in many cases the boundary between factory and domestic production was blurred, due to changes in legislation relating to definitions of a 'factory'.

Orphans provided a substantial part of the labour force of early textile factories, and numbers increased in the second half of the eighteenth century. Supply was increasing for two reasons. First, improved standards in orphan care in institutions increased survival rates.¹ Second, the larger numbers led to an increased financial burden on the state, which despatched children to textile mills to alleviate liability. On the demand side the number of textile mills was rapidly increasing. Changes in the labour market for orphans led to higher participation rates and younger starting ages compared to children with

Table 1 Children under ten years of age employed in the textile industry as a percentage of the factory labour force, 1833–1835.

Sector	1833	1835
Cotton	0.86	0.32
Wool	3.60	1.20
Flax	1.00	0.46
Silk	7.72	7.28

Source: 1833 figures, C. Nardinelli, *Child labour in the Industrial Revolution* (Indiana University Press, 1990), 105. 1835 figures B.R. Mitchell, *Abstracts of British historical statistics* (Cambridge, 1962), 188, 199, 204, 211.

parents. The silk industry was the first section of the textile industry to develop factory production, and when the first effective child labour laws were passed in 1833 silk mills were the most extensive employers of children in the British textile industry, and also employed children at particularly young ages.²

Table 1 shows the proportion of young children employed in the silk industry before and after the 1833 Factory Act. The data highlights two key points: the relative high proportion of children employed prior to regulation, and how the exclusion of silk mills from the legislation increased the disparity.

The silk industry was prone to spectacular fluctuations in employment, output and investment, primarily due to violent fluctuations in the price of raw silk and trading relationships with France. But there were a host of other smaller factors which could also destabilise the industry, as a report on the Coventry ribbon trade demonstrates:

The silk ribbon trade was good in the first half of the year and then fell off somewhat – owing probably to a change in fashion, or the wet summer, or court mourning, or the practise of ladies at the seaside wearing caps without ribbons, or all combined.³

Table 2 shows the silk industry, unlike other branches of textiles, was not regionally based. The largest concentration was in Cheshire, which included Macclesfield, the centre of nineteenth-century silk manufacture.

The early debate

In the first half of the nineteenth century conventional wisdom suggested that children employed in the silk industry experienced relatively benign working conditions compared to their contemporaries.

If a poor man's child has to work, it is impossible that there can be employment less objectionable than that of the silk trade.⁴

The occupation of children in the silk factories is more conducive to health than confinement in an ordinary school would be.⁵

Table 2 Number of British silk mills and workers, 1838 and 1850.

COUNTY	MILLS		WORKERS	
	1838	1850	1838	1850
Berkshire	3	0	181	0
Buckinghamshire	2	1	118	225
Cheshire	92	97	*11,832	12,397
Derbyshire	20	24	3,216	4,880
Devon	3	2	405	472
Dorset	5	5	333	634
Essex	7	6	1,441	2,313
Gloucestershire	2	7	123	852
Hampshire	2	1	222	111
Hertfordshire	6	4	784	976
Kent	1	1	40	86
Lancashire	31	29	5,591	8,208
Middlesex	1	4	154	409
Norfolk	4	4	2,274	1,350
Nottinghamshire	4	4	449	409
Somerset	24	15	2065	1,745
Staffordshire	12	10	1,494	1,493
Surrey	1	0	65	0
Suffolk	3	3	465	578
Warwickshire	9	23	535	1,989
Wiltshire	5	3	359	300
Worcestershire	10	13	334	668
Yorkshire	16	16	1,084	1,688
England Total	263	272	23,555	41,783
Scotland	5	5	763	841
United Kingdom				
Total	268	277	24,318	42,624

Note: *This figure given by Jenkins as 1,832, is clearly an error. The 11,832 is figure is derived from the 1850 figure for Cheshire and the ratio of workers to mills.

Source: D.T. Jenkins, 'The validity of the Factory Returns 1833–50' *Textile History*, 4 (1973), 42–7.

These statements represent a body of medical opinion which supported silk manufacturers throughout the first half of the nineteenth century in their defence of child employment in silk mills. The argument was first presented in 1816 in order to persuade legislators to exclude silk from regulations applied to cotton manufacture. Indeed, in 1832 Samuel Courtauld, one of the largest silk manufacturers in nineteenth-century Britain, quoted these assertions when

responding to questions from a Board of Commissioners' investigation. He suggested that evidence produced in 1816 proved it was not necessary to regulate child labour in silk mills.

The occupation was perfectly innocuous; the labour light and suitable for children; their health was not effected; nor their constitution impaired; they grew up as robust and vigorous as persons engaged in the normal avocation of life; and in consequence of such evidence the silk manufacturer was exempted from the operation of the bill.⁶

Courtauld stated that the working environment of silk manufacture was more benign than cotton due to the absence of 'deleterious particles' in the production process, informing the commission that silk is worked at moderate temperatures, and factories and mills were well ventilated.⁷

Courtauld's view was supported from a number of other sources. In 1815 the Macclesfield Courier carried an advertisement for 100 men, women and children with experience of silk to work in a factory recently erected in Tottenham, London, described as 'the pleasantest in England'.⁸ Thomas Ward, silk throwster of Bridgewater, claimed conditions were so favourable that 'children frequently requested to be employed longer when we have extra work'.⁹ In the 1830s John Grout, one of the largest silk manufacturers in England, described the labour of children working in his mill as 'extremely light' and 'gentle exercise'.¹⁰ John Wright, steward at a Macclesfield silk mill, who had worked in the silk industry for over 30 years, disagreed. He observed that the propensity of silk mills to take children at a much younger age than cotton factories, often at five or six, resulted in an alarming number of cripples in later life. In one small area of the town there were 63 cripples.¹¹

As the following extracts from the Macclesfield Courier illustrate, the working environments of silk mills were not free from hazard:¹²

Last week another of those unfortunate circumstances too frequently attendant on silk machinery, occurred at a silk factory near the common in this town. A young boy.....whose clothes got entangled in the machinery, met his death by strangulation.

A little girl about seven years of age was caught by her clothes and drawn between an upright shaft in the engine room and a wall.....life was extinct.

Ralph Boothby, about five years of age, was unfortunately caught by one of the shafts or wheels.... Killed on the spot.

William Downs about eight years of age....The shaft caught the strings of his pinafore.....died immediately.

Dangerous working conditions were exacerbated by the harsh discipline imposed by stewards, who commonly beat children with straps. One such assault resulted in the death of 11 year-old Sarah Stubbs, who worked as a 'piecer' in a Macclesfield mill, the inquest revealing that she was repeatedly

beaten for not tying broken silk threads at the required rate.¹³ Evidence given by Daniel Fraser, a silk mill department manager, gives a highly negative account of the conditions children endured:

The children were taken at a very early age and they exhibited great fatigue daily. In the mornings they would fall asleep after breakfast... The young children were strapped frequently with leather thongs... There was no provision for sitting down... The hands principally comprised of females, who were considered more docile than males, but were less capable of enduring the conditions... Inadequate ventilation caused them to faint... The girls have hoarse, rough voices, as if they are not right within ... The children had to work in silence... I have seen boys kicked.¹⁴

Many of the recorded instances of the mistreatment of children were associated with wasting silk, 'one of the highest crimes in the throwing mill'.¹⁵

Fraser's evidence was supported by James Turner, a Manchester cotton dresser, who testified that in Manchester children worked longer hours in silk mills compared to cotton., that child workers in silk started work at younger ages and that 'the children look more ghastly and pale than they ever did in cotton'.¹⁶ Turner went on to describe their working conditions. He said it was well known that the children were chastised severely if they were seen making waste.¹⁷ When asked if he thought the regulation of child labour was necessary in silk mills he replied:

I think there is more necessity for it in the silk-mills than in any other mills, which I am acquainted.¹⁸

Turner highlighted a particularly distasteful procedure designed to increase production levels: prizes were awarded to the most productive children. He described the case of two young boys competing for 'three pounds of bacon and threescore of potatoes'¹⁹ over a two-week period. The boy who won complained that when he got home he could hardly get into bed due to the exertion of his labours. For girls, dolls were hung from the frames of machines to encourage greater effort. The performances of the winners of these competitions were then set as standards, and children falling short were punished. Similarly in Macclesfield, failure to achieve set standards often resulted in children being ridiculed by being made to wear a 'badge of idleness'.²⁰

By the 1840s the exclusion of silk mills from the 1833 Factory Act began to attract the factory inspectors' attention.

Next stands the silk manufacture: we will not fill our pages with abundant evidence that may be found in the Minutes of the Committee and the reports of the inspectors. Suffice it here to say, that ten hours of labour, in each day, are assigned to children of tender years, of eight, of seven, and even of six – *mostly girls* – and so small, we learn from the inspectors, that they are not infrequently placed upon stools before they can reach their work.²¹

However, as mid-century approached silk manufacturers still maintained regulation was unnecessary.

The lightness, cleanliness, and freedom from dust and minute particles, a cooler atmosphere required in silk throwing, all concur to point it out as a healthful occupation; a fact borne out by the general health of the silk mill hands of Derby. As regards the health and comfort of the children it has been found in coming to work after breakfast, at 8 o'clock in the morning, and leaving off at 7 o'clock in the evening, uniformly throughout the year, has been highly advantageous to the health and general comfort of all the persons employed, but especially of the children.....The silk-throwsters of Derby challenge the whole world to show a more healthful manufacturing population.²²

At this time Chadwick was investigating the living standards of the 'labouring classes.' When visiting the silk weaving district of Spitalfields he commented:

The chances of life of the labouring classes of Spitalfields are amongst the lowest that I have met with, and there it is observed of weavers, though not originally a large race, that they have become still more diminutive under the noxious influences to which they are subject.....They are decayed in the bodies; the whole race of them is rapidly descending to the size of Lilliputians. You could not raise a grenadier company amongst them all. The old men have better complexions than the young.²³

The work of Chadwick and other social reformers was instrumental in the formation of the General Board of Health in 1848. In 1854 responsibility for public health was passed to a newly formed Committee of the Privy Council that was headed by the Chief Medical Officer, John Simon.

Growing awareness

By 1850 there was enough evidence to suggest that factory work provided a nexus for debilitating and shortening the lives of operatives.²⁴ Throughout the 1850s Simon campaigned for legislation to safeguard workers employed in occupations he believed were hazardous to health. In 1856 he secured the position of first Lectureship in Public Health in Britain for Dr Edward Greenhow, soon after which Greenhow set out to interpret statistics gathered by the Registrar General.

In 1860 Simon authorised Greenhow to report on districts with high mortality rates caused by lung disease. The investigation was primarily concerned with adult mortality, and sought to explain the higher death rates from lung disease found in manufacturing districts. In some cases these death rates differed by a factor of six.²⁵ The most prominent contributor by far to 'lung disease' was tuberculosis. Consumption—phthisis, or pulmonary tuberculosis, as it was alternatively known—killed more people, especially in young adulthood, than any other disease in the nineteenth century.²⁶ Overcrowding, diet and unsanitary conditions at home and at work were of 'profound significance' in

shaping the its mortality patterns.²⁷ Cronjé singles out high male mortality in the nineteenth-century textile industry, suggesting that the general unhygienic working environment and specific factors such as silica dust, encouraged tuberculosis. However, dust was not a health-hazard in silk manufacturing as it was in other areas of nineteenth-century textiles.

Cronjé suggests the explanation for high tuberculosis mortality in the nineteenth century accords with modern studies of occupational mortality, which stress the role of excessive crowding in the workplace as an important way of spreading tuberculosis.²⁸ She identifies a number of nineteenth-century occupations, such as tin-mining and earthenware production, which displayed 'exceptionally high rates of tuberculosis mortality.'²⁹ The link between overcrowding and tuberculosis was noted by Dr Baly, a physician researching the causes of tuberculosis in the first half of the nineteenth century from the medical records of a sample of the London prison population, which showed the mortality rate for tubercular disease here to be four times higher than that of the general population of the capital.³⁰ Dr Baly concluded that this influence, along with poor diet, arose from deficient ventilation, sedentary occupations and a lack of active bodily exercise. Simon noted that the factors highlighted by Dr Baly were also prevalent in the lives of some textile factory populations, and that these conditions increased the probability of tubercular disease:

Where an industrial system is bad – bad, either in excessive length of daily work, or in the over-crowdedness and non-ventilation of workplaces, these evils may be vastly developed. Their maximum may be expected to prevail in places where an over-tasked population does its work in ill-ventilated factories and cottages.³¹

It will be shown that not only was the silk industry an integral part of this 'bad industrial system' but the above conditions were exacerbated by the fact that younger children worked for longer hours relative to children employed in other areas of textile production.

The Medical Officer for the Privy Council set out to ascertain whether the high mortality rates from phthisis in certain manufacturing areas were an essential appendage of employment or whether they could be attributed to sanitary problems. Table 3 shows the incidence of pulmonary disease in each district he studied, the industry and the gender which was predominately employed.

The mortality statistics in Table 3 are for the district population, not just those actually employed: the contrasts would have been more striking if death rates had been calculated solely for the workforce of each industry. Nor is the data age specific. This said, the data provides a mid-century snapshot of Britain's occupational disease blackspots, and shows Macclesfield had the highest incidence of deaths from pulmonary disease among females, with Leek displaying the fifth highest rate. The death rate for males was lower in both Macclesfield and Leek, eighth and thirteenth respectively of the 23 districts investigated.

Table 3 Death rate from pulmonary disease in selected manufacturing districts, 1848–1854.

Population in 1851	Registration District	Prevalent Industry	Death-Rate ¹		Employed Sex
			Male	Female	
57,942	Stoke-upon-Trent	Pottery Manufacture	721	665	M and F
41,916	Wolstanton	Pottery Manufacture	726	727	M and F
24,822	Bromsgrove	Ironwork	583	559	M and F
17,482	Alcester	Ironwork	539	577	M and F
103,626	Sheffield	Ironwork	839	670	M and F
53,517	Penzance	Tin/Copper Mining	560	456	M
53,628	Redruth	Tin/Copper Mining	670	450	M
6,820	Reeth	Lead Mining	724	528	M
7,579	Patley Bridge	Flax Manufacture	508	391	M and F
63,237	Macclesfield	Silk Manufacture	691	804	M and F
23,031	Leek	Silk Manufacture	588	705	M and F
101,343	Leeds	Wool Manufacture	817	718	M and F
181,964	Bradford	Wool Manufacture	611	603	M and F
37,386	Stroud	Wool Manufacture	511	511	M and F
18,815	Melksham	Wool Manufacture	626	559	M and F
60,642	Leicester	Hosiery	740	659	M and F
15,595	Hinckley	Hosiery	652	603	M and F
96,545	Preston	Cotton Manufacture	776	768	M and F
12,806	Towcester	Lace-making	475	573	M and F
23,109	Newport Pagnall	Lace-making	490	545	F
12,527	Berkhampstead	Straw-plaiting	401	566	F
28,463	Yeovil	Glove-making	528	591	F
20,716	Saffron Walden ²	Agriculture	520	612	M and F

Standard Districts used for Comparison

56,637	6 Northern	Miscellaneous	297	304	M and F
71,330	6 Southern	Miscellaneous	411	454	M and F
183,154	10 South-Western	Miscellaneous	446	395	M and F

Note: ¹ Death rate is per 100,000 calculated for 1848–54, except for Standard Districts calculated for 1849–54.

² Causes of pulmonary disease in this district were not of an occupational kind.

Source: *British Parliamentary Papers, 1861, XVI, Third Report of the Medical Officer of the Privy Council, pp.376–7.*

When visiting Macclesfield and Leek, Greenhow began his report by outlining the demographic and occupational profile of the districts:

Silk is the staple article of manufacture of both Macclesfield and Leek. In 1851 the town of Macclesfield contained 39,048 and Leek 8,877. Each

Table 4 Death rate per 1,000 in Macclesfield, Leek and surrounding areas, 1860.

District	Male	Female
Macclesfield Registration District	6.03	7.21
Macclesfield Town	7.43	8.13
Prestbury, Bollington, Rainow, Gosforth and Alderly sub- districts	5.91	6.86
Leek Registration District	5.53	6.71
Leek Town	7.80	8.51
Norton, Longoor and Leek Frith sub-districts	4.60	5.13
Standard Districts used for Comparison		
6 Districts in Northumberland and Cumberland	2.97	3.04
10 districts in Devonshire and Cornwall	4.46	3.95

Source: *British Parliamentary Papers, 1861, XVI, Third Report of the Medical Officer of the Privy Council, p.496.*

Registration district comprises of several villages and hamlets, and a considerable rural population. When the census of 1851 was taken 31 per cent of the men and 26 per cent of the women of Macclesfield, above 20 years of age were employed in the silk manufacture. About 19 per cent of men were engaged in the cultivation of the soil, and a small proportion engaged in cotton manufacture and in mining. About 15 per cent of the men and 17 per cent of the women of Leek, above the age of 20 years, at the same date were employed in the manufacture of silk: 37 per cent, or more than one third, of the men were occupied by the cultivation of the soil, and 7 per cent in mining. A large, but uncertain proportion of young women, boys and girls, are also employed in silk manufacture in both places.

The town in both districts is the centre of the silk manufacture: but whilst in Leek this manufacture is confined to the town and its immediate precincts, it extends, throughout the registration district of Macclesfield. Neither Leek nor Macclesfield were densely built. The former contains some narrow streets, and courts, but the principal streets are wide and airy. The latter has for a town of its size an unusual number of open spaces. These districts differ in this respect, that while the manufactures of Macclesfield, with the exception of weaving, are chiefly carried on in factories, a large portion of the work in Leek is done at home, in workshops and in sheds, which can scarcely be called factories.³²

Given that both towns were the centre of silk manufacture in each district, it is significant that Table 4 shows the highest mortality rates occurred in the towns.

Greenhow's account of housing conditions of Macclesfield and Leek are crucial in determining the source of contagion: he found both towns to be 'sometimes,

but by no means generally overcrowded.³³ The worst cases of overcrowding were recorded in the lodgings of unmarried factory operatives in Leek, the smallest bedrooms of which offered 280–310 cubic feet of breathing space per person—above the minimum of 240 cubic feet required by the Common Lodgings Act of 1855. Greenhow concluded, ‘the dwellings of the labouring classes, in both towns are superior to those in many agricultural districts.’³⁴

The working environments of the children employed in silk manufacture in Macclesfield and Leek differed. In Macclesfield most child labour was employed in large silk mills, therefore subject to some regulation. In Leek the majority of young children were employed domestically, or in workshops, subject to no regulation. In Leek, Greenhow found many boys and girls aged 8–9 working for 10 hours per day where ‘ventilation was most imperfect.’³⁵ In one workshop he found 51 men, women and children crammed into a space which afforded them less 200 cubic feet per head—below the minimum requirement—and therefore these children were exposed to two of the major causal factors of tuberculosis, overcrowding and deficient ventilation.³⁶

Greenhow also calculated that boys employed in twisting sheds traversed ten miles per day on average. Three were ‘no more than nine years of age’ and were a ‘short stunted race.’³⁷ As far he could ascertain, they were not subject to any special ailments, but the medical officer responsible for determining physical condition of potential army recruits in the area remarked that he rarely found thread-twisters fit for service.³⁸ Macclesfield and Leek death registers provided Greenhow with further evidence, recording high death rates for males over 20 years of age working in silk manufacture. Deaths among young girls employed in silk had been ‘very numerous’, but there was no data from which to compare their mortality rate with the rest of the population.³⁹

Three years prior to Greenhow’s investigation, a report on the sanitary conditions of Leek by its medical practitioners found that imperfect ventilation of the factories was a significant contributory factor to the high rates of mortality from pulmonary disorders.⁴⁰ Greenhow carried out a detailed inspection of the ventilation systems of the mills of Macclesfield and Leek and found ‘The ventilation of most of the mills in both towns to be very imperfect.’⁴¹ The ventilation systems consisted of casements designed such that drafts entered the workrooms at head height. The operatives found the working conditions so intolerable that they closed them during working hours. In many cases the systems were so stiff from misuse they could not be opened. The defective systems produced a stagnant atmosphere, exacerbated by general overcrowding in the workrooms, which were well below the minimum standards required. The situation was further aggravated by high working temperatures, which caused windows to be perpetually covered in steam.

Greenhow was not the first to draw the unhealthy working environments of silk mills to the attention of the legislature. In 1840 factory inspector Leonard Horner recorded:

Much has been said about the greater cleanliness of silk mills, and the greater lightness of the work, in order to prove that the employment is more healthy than that in other mills. If we visit the large and newly erected silk factories, we certainly find the rooms large and airy; but so are newly erected cotton, woollen and flax mills. If we visit the older silk mills, these constitute the majority, we find that the rooms are very frequently small, low in the roof and badly constructed. In all silk mills there is a greater vitiation of the air than in other mills because of the much larger company of persons collected together in the same place.⁴²

Inadequate ventilation, high temperatures and overcrowding were not the only health hazards: both weavers and piecers worked in constrained positions injurious to health. The posture of weavers, chest pressed against a wooden beam, compressed the stomach and the chest and caused many of them to become round-shouldered and narrow-chested. Piecers, who were principally young girls, worked standing and were constantly in motion, stooping forward to tie the broken threads. Many piecers worked in winding sheds which did not use steam-power, hence were not subject to factory regulations. Repetitive movement coupled by long working hours seriously impaired respiration. Greenhow reported that piecers contributed to an 'undue proportion' of the mortality from pulmonary diseases in Leek and Macclesfield, and medical practitioners confirmed that female operatives were 'very liable' to diseases of the chest.⁴³ Foremen of several silk mills corroborated this evidence.

The following year Greenhow visited Coventry. He found 34 per cent of men and 44 per cent of women over 20 years or age employed in silk manufacturing. There were also many young people of both sexes employed in silk factories and many more women and children employed domestically. Silk manufacturing was by far the most prevalent occupation.⁴⁴ Coventry was not densely built upon and contained many open spaces. The courts inhabited by the working classes were large, open and well ventilated. There were some back to back houses in the older part of the city that were small and poorly ventilated, but generally Greenhow found the majority of dwellings to be well ventilated.⁴⁵

The death rate per 100,000 from lung disease in Coventry 1848–54 was 661 for men and 573 for women. These figures were higher than the standard rates in Table 3, but lower than those of Macclesfield and Leek. Greenhow found the variation in female mortality remarkable given that they were employed in the same occupation. He believed these differences were attributable to the larger proportion of females employed in handloom weaving in Macclesfield compared to Coventry, the stooping position of piecers while at work and the unsanitary, ill ventilated, overcrowded workplaces of Leek.⁴⁶

There are other factors that may contribute to the variation in mortality rates. Coventry had modern factories which possessed a unique feature, the cottage factory, which were powered by steam and subject to factory regulation, unlike the small workshops of Macclesfield and Leek. At the time of Greenhow's visit the Coventry silk industry was in a state of depression and many of the cottage

factories were idle, due to the Anglo-French Cobden-Chevalier treaty of 1860 which removed the protective tariffs on French silk goods similar to those produced in Coventry. The poor state of trade in Coventry prompted the cottage weaving factories, which were still producing silk goods, to regress by substituting the hand power of small boys for steam power.⁴⁷

After completing his inspection of the workrooms of the Coventry factories, Greenhow found them to be 'rarely overcrowded.' However, there were exceptions where he found women and children working in rooms below minimum standards.⁴⁸ Unlike Leek and Macclesfield, Coventry offered a variety of ventilation systems. The best systems had casements in each window which opened at a height to avoid air currents striking the heads of the operatives. Some factories had grates in the floor which allowed air to circulate. But in others the only means of ventilation were ill-positioned casements similar in type to those commonly found in Macclesfield and Leek, and there were a number of factories with ventilation arrangements which replicated those of Macclesfield and Leek in which the atmosphere was 'oppressively hot'. The cottage factories were not overcrowded, however, Greenhow estimating there was between 420–640 cubic feet per head. The reason for this was the height of the workshops, at least 13ft high to accommodate the Jacquard looms employed. Greenhow came across a silk factory in Foleshill where openings in the ceiling had been made to improve ventilation, not to ameliorate the working environment but to avoid damage caused by gas-heated air to pattern cards used in weaving with Jacquard looms.

The local authorities of Coventry were energetic in their pursuit of sanitary reform. Indeed, Greenhow commented that 'there are few places where so much has been attempted for the improvement of the public health'. However, when he inspected a new factory built under the supervision of the local authorities he found it to be inadequately ventilated. The rooms were hot and close and the ventilation openings were positioned such that workers were exposed to drafts of cold air at head height. Greenhow concluded many of the 'evils' of Macclesfield and Leek were present in Coventry, but they were not as detrimental to the silk workers' health as the mills were more spacious. Furthermore, Coventry silk workers were not subject to the 'bad effects' of stooping, common in Macclesfield, and their children were not exposed to factory work at very early ages, commonplace in the winding rooms of Leek.⁴⁹

Similar to Leek and Macclesfield, local medical practitioners had already been aware of the high mortality from lung diseases in Coventry before Greenhow submitted his findings. One practitioner stated that he believed the high mortality rates were a direct consequence of the industrial labours of the people, especially those who worked in ill-ventilated over-heated workplaces.⁵⁰

In 1864 Simon concluded his investigation into districts with excessively high mortality rates from lung diseases.

When many persons are employed together in an indoor industry, the ventilation of the workplace is likely to be so bad as to convert the employment, which perhaps in its own nature is not of hurtful tendency, into an employment seriously dangerous to health.⁵¹

He suggested bad ventilation in the workplace was responsible for the development of a 'large excess of phthises, and probably some excess of other fatal lung diseases' among workers. He maintained that in districts which had large indoor industries, the 'prevalence of workplace-induced lung disease was sufficient to colour the death return of the whole district with a marked excess of lung-disease'. Simon noted that the silk manufacturing districts of Leek, Macclesfield and Congleton had by far the highest mortality rates, emphasising the 'atrocious sanitary circumstances under which much of our silk industry is conducted', his reports making it quite clear that the working conditions in the nineteenth-century silk industry were far from healthy. The high mortality rates associated with silk production were not the product of an 'occupational disease', for the processes of silk production were not particularly harmful to health. The fact, therefore, that silk manufacturing districts displayed higher mortality rates from lung diseases than cotton manufacturing districts is of greater significance, given that cotton production was carried out in dust-filled atmospheres.

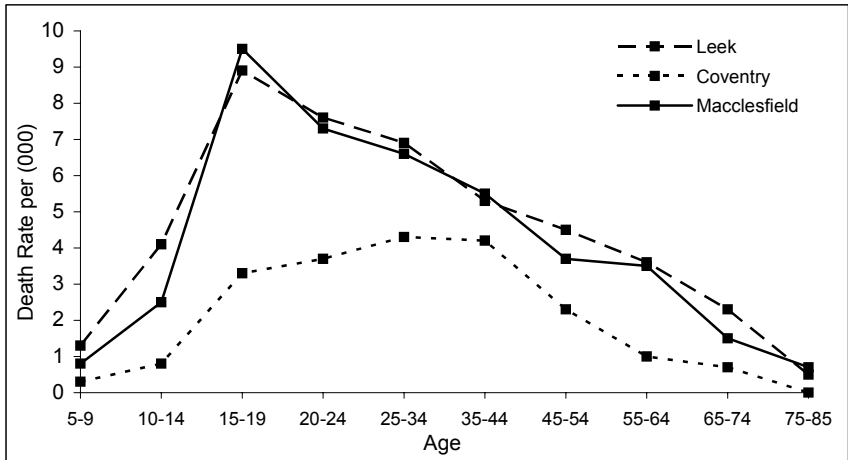
The evidence of the mortality data

Decennial reports of the Registrar General were used to plot the age-specific mortality rates from phthisis in silk manufacturing districts relative to other manufacturing areas. The data was recorded at uneven intervals. The mortality of children up to five years of age was recorded at yearly intervals, from five to twenty four years at five-year intervals and all subsequent age categories were recorded at ten-year periods. Children below five did not constitute part of the factory workforce and therefore this data was not used.

Mortality will be displayed as death rate per thousand, calculated from the Registrar General's cumulative total of phthisis mortality per decade. This will facilitate comparisons of child mortality between textile districts. The first reliable decadal estimates emerged in the second half of the nineteenth century, fortuitously coinciding with the period 1850–70 when children employed in silk mills were subject to the discriminatory legislation of the 1844 Factory Act. This unique set of circumstances offers the opportunity to quantify the consequences of partial regulation on their health. Extending the analysis beyond these decades is hindered due to mortality statistics for the 1870s giving no gender distinction by age group. Furthermore, by this time the regulations applied to children working in silk mills had fallen into line with other sections of the textile industry.

It is important to note that the age-specific mortality pattern of phthisis was different from trends in general death rates. The normal pattern of mortality in the nineteenth century was high death rates during infancy and early childhood, followed by a steady fall through late childhood and adolescence.

Figure 1 Comparison of female phthisis mortality in silk districts, 1851–1860.



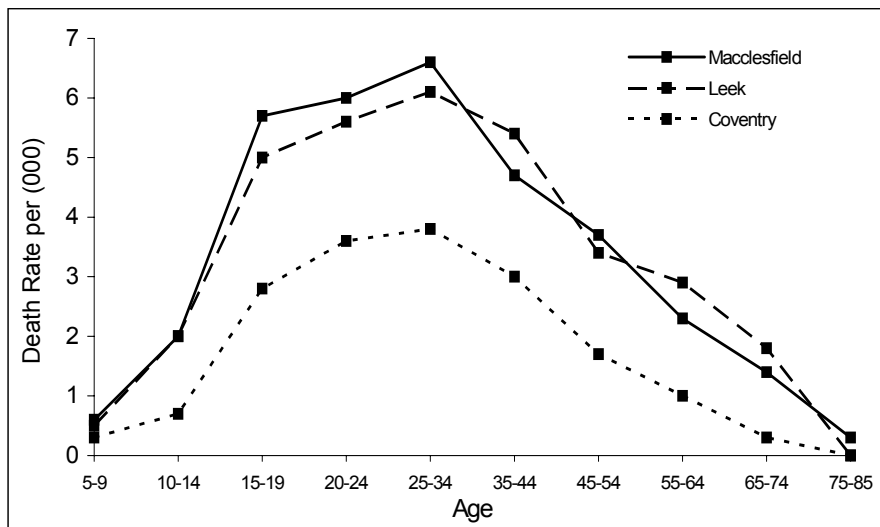
Source: Registrar General's Decennial Reports 1851–1860.

Throughout young adulthood death rates, although gradually rising, remained low, followed by a sharp increase in mortality in the 35–44 age group with death rates finally peaking in higher age categories. By contrast, phthisis mortality rates, after initially conforming to the general trend, began to rise in the 10–14 age group, peaking in young adulthood and then steadily declining across the higher age categories.⁵²

In Figure 1 Coventry displays lower rates of female mortality in all age groups compared to Macclesfield and Leek, which have remarkably similar mortality patterns. What is interesting is that the highest variations occur in the 10–14 age group, where mortality amongst children in Leek (4.1) and Macclesfield (2.5) are five and three times respectively that of Coventry (0.8). Mortality in both Leek and Macclesfield peaks in the 14–19 age group, whereas in Coventry mortality peaks at age 35–44.

In Figure 2 mortality has declined in all three districts. The decrease corresponds to the general fall in phthisis mortality for both sexes, and all age categories, throughout England and Wales in the second half of the nineteenth century. As in Figure 1, Macclesfield and Leek display much higher mortality than Coventry, the greatest variation being at ages 10–14. One interesting feature is how the configuration of the curves have changed, with peak mortality now occurring in the 25–34 age group in each district. This shift was part of a general trend throughout the second half of the nineteenth century, which witnessed a move of peak mortality to progressively higher age categories, the explanation for which lies in adult tuberculosis resistance levels. Childhood conditions were crucial to an individual's later ability to resist tuberculosis. A well established but contained infection could be reactivated in

Figure 2 Comparison of female phthisis mortality in silk districts, 1861–1870.



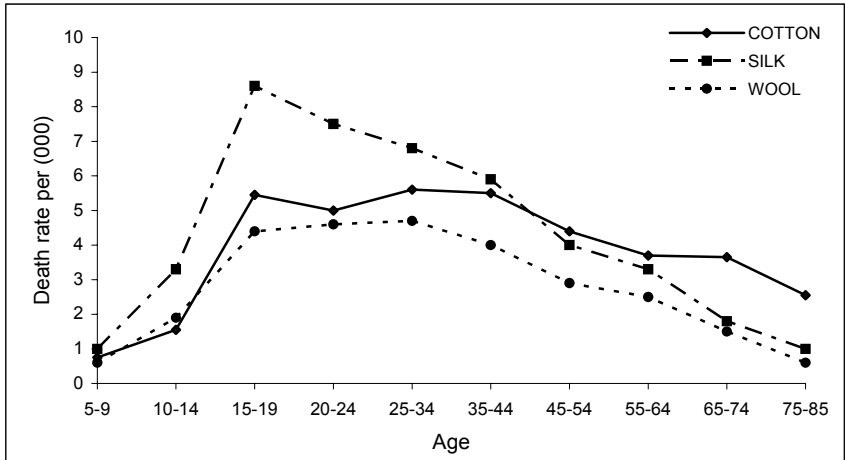
Source: Registrar General's Decennial Reports 1861–1870.

adulthood. Therefore improved diet, working and living conditions in the second half of the nineteenth century contributed to increased resistance to tuberculosis in childhood years. This in turn led to a reduction in the number of tuberculosis fatalities in young adulthood and to relatively more, older adults having a greater susceptibility to tuberculosis because their childhood circumstances had been worse than those of succeeding generations.⁵³

What was the contribution of housing, diet and working conditions to the high levels of phthisis mortality in Leek and Macclesfield compared with Coventry? Greenhow had found no significant difference in the quality and density of housing, nor excessive overcrowding in any of the towns in terms of cubic breathing space per head. Diet was dependent upon income levels. But the income levels of these local economies were linked in that they were vulnerable to the same external forces, while Macclesfield silk throwsters provided much of the silk yarn for Coventry silk weavers. Therefore it is unlikely that there were significant variations in changes in income level between these areas. The working conditions of Coventry, however, differed markedly from those of Leek and Macclesfield. Factories were relatively modern and generally equipped with superior ventilation systems and the use cottage factories meant fewer cases of overcrowding. Child workers did not suffer the consequences of repetitive stooping associated with 'piecing' and started work at older ages.⁵⁴

Recent research by Woods and Shelton investigating the decline of phthisis mortality in Victorian England and Wales found no evidence that

Figure 3 Comparison of female phthisis mortality in textile districts, 1851–1860.



Source: Registrar General's Decennial Reports 1851–60.

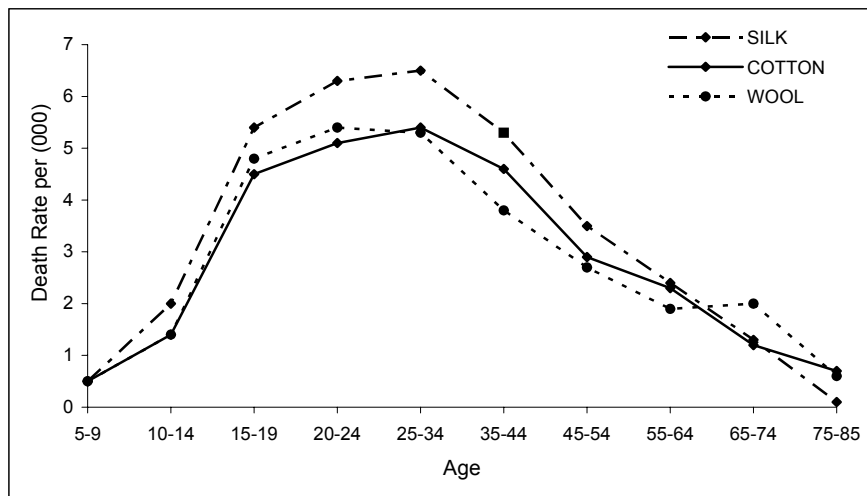
improvement in housing and diet were significant factors in accounting for the reduction. They found many of the districts with highest levels of phthisis mortality were remote rural areas and concluded that mortality rates were high in these areas because 'infection and reinfection rates were high. Housing may be both poor and overcrowded, but in general this does not provide support for interpretations that emphasise either change in nutritional status or the quality of housing or indeed some synergistic interaction between the two.'⁵⁵ They reject the hypothesis that persistent geographical differentiation in tuberculosis death rates should be mirrored by quality of life. The principal reason for a reduction in mortality was that the disease became less virulent.

From the perspective of this research, however, the issue is not what caused the decline in phthisis mortality, but why phthisis mortality was so high in silk manufacturing districts. The evidence presented so far suggests the key variable in explaining variations in phthisis mortality in silk manufacturing districts was their working environments, providing an ideal habitat for the disease to flourish.

What follows is a comparison of age-specific phthisis mortality in silk manufacturing districts with other sectors of the textile industry. The districts chosen to represent each textile sector were selected from those investigated by the Medical Officer of the Privy Council due to their high rates of phthisis mortality: silk (Macclesfield, Leek and Congleton), cotton (Preston and Blackburn) and wool (Bradford and Leeds).

Figure 3 shows that silk districts display higher rates of phthisis mortality in all age categories compared to wool, the largest differences occurring in the 10–24

Figure 4 Comparison of female phthisis mortality in textile districts, 1861–1870.



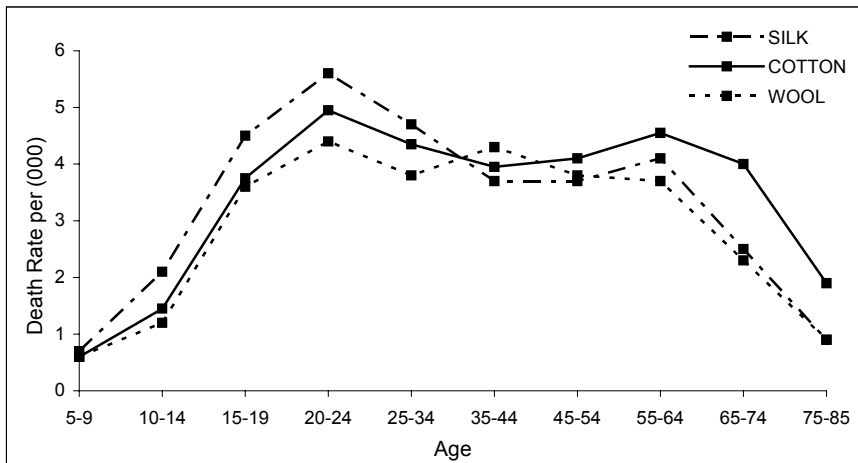
Source: Registrar General's Decennial Reports 1861–70.

age range. Compared to cotton, silk districts show higher mortality rates until a crossover point around the age of 40, again the largest differences occurring in the 10–24 age categories. Peak mortality in silk districts occurs earlier and is more salient than either cotton or wool, with a steep increase from 10–14 to 15–19, from which point there is a gradual decline throughout older age categories. Both cotton and wool districts display broad peaks ranging from 15–44, roughly corresponding to the general distribution of female phthisis mortality in nineteenth-century England and Wales.⁵⁶ Within this broad peak phthisis mortality was at its highest (4.6 per 1,000) in the 25–34 age group.⁵⁷

Figure 4 compares female phthisis mortality in the following decade. In the 1860s there was a 10.3 per cent decline in female phthisis mortality in England and Wales.⁵⁸ In Figure. 4 the reduction is evident in both wool and cotton districts. In silk areas, not only is there a fall in mortality but the configuration of the mortality curve has changed, with silk districts displaying a 'broad peak' associated with the general pattern of female phthisis mortality in this period. Silk districts still show higher mortality in all age categories up to the final two age groups, but the large differences of the previous decade are no longer discernible.

Figures 5 and 6 compare male mortality. In Figure 5 all districts share a very broad plateau of peak mortality in the 15–64 age groups, more extended than the broad peak apparent in the general distribution of male phthisis mortality in England and Wales.⁵⁹ The extended plateau is attributable to the very high rates of pulmonary disease generally associated with textile production, which made them tuberculosis blackspots.⁶⁰ Within this peak age group phthisis mortality was at its highest (4.1 per 1,000) in the 20–24 age group.⁶¹ The silk

Figure 5 Comparison of male phthisis mortality in textile districts, 1851–1860.



Source: Registrar General's Decennial Reports 1851–60.

districts display higher death rates at all ages up to and including the 25–34 category. Furthermore, in the 10–14 group mortality is twice that of other textile areas.

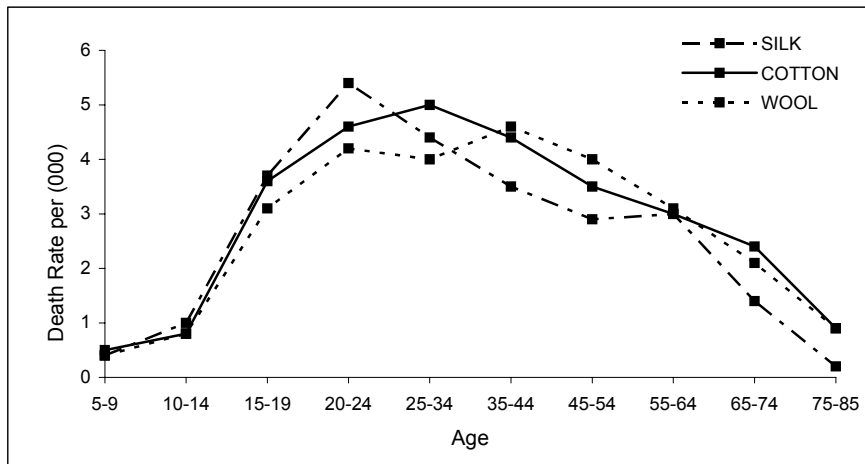
Figure 6 compares male phthisis mortality in the 1860s when there was a 3.7 per cent decline in male phthisis mortality across England and Wales—one third the reduction recorded for females in the same period. The excess male mortality of silk is no longer apparent. All three textile districts display similar mortality patterns, although each district peaks in a different age group. Unlike the previous decade, there are no significant variations in child mortality.

The influence of working conditions on phthisis mortality in silk districts is therefore demonstrated by its relative prevalence during the 1850s, and by its relative decline compared to that of textile districts by the 1860s. From 1860 the Anglo-French trade agreement produced a dramatic reduction in the number of people employed in the British silk industry, the total workforce falling from 118,320 to 82,963, male employment from 43,732 to 29,225 and female employment from 72,588 to 52,738.⁶² The reduction in numbers coincided with the decrease in phthisis mortality observed above.

Conclusion

It is clear that the working environments of silk manufacture were not as benign as proposed by manufacturers: working conditions associated with factory production in the silk industry were a major contributory factor to the high tuberculosis mortality recorded among children and young adults in these districts. Therefore one of the twin pillars on which silk manufacturers built their case for exemption from regulation was at best unstable.

Figure 6 Comparison of male phthisis mortality in textile districts, 1861–1870.



Source: Registrar General's Decennial Reports 1861–70.

For the first half of the nineteenth century there is ample qualitative evidence to suggest that the conditions experienced by children employed in silk factories were at least on a par with those in other textile factories. However, there were two factors which exacerbated their situation. First, the discriminatory factory legislation of the 1833 Factory Act left very young children unprotected. Second, the high value of silk relative to other textiles resulted in much harsher disciplining of children, particularly if children were responsible for 'making waste.'

In the first half of the century the only grounds silk manufacturers had for maintaining that silk mills afforded healthier working environments than other textile mills was dust-free atmospheres. In the second half of the nineteenth century this tentative assertion was disproved. In fact it was the atmospheres of silk mills that contributed to the extremely high mortality rates in silk manufacturing districts. The most damning evidence comes from the mortality statistics of the Registrar General. Comparative analysis of the data reveals extremely high mortality amongst children and young adults from tuberculosis in silk manufacturing districts compared other textile areas. Furthermore, tuberculosis death rates in these age groups exceeded Victorian Britain's mortality blackspots of Manchester and Liverpool.⁶³

The largest differences in mortality rates occurred in young girls. This is significant since silk mills had a much higher female/male ratio, particularly amongst children, compared to other sectors of the textile industry. In the 1850s tuberculosis mortality amongst girls aged 10–14 was three times that of cotton and wool districts. Discriminatory regulation played a crucial role in the high tuberculosis mortality for these children. The 1844 Factory Act allowed

11–13 year olds in silk mills to be employed full-time. Children in this age group working in other branches of the textile industry had their working hours reduced by the introduction of the half-time system. Therefore young silk workers were exposed to atrocious working environments for twice as many hours per working day.

The appalling working conditions in the silk factories of Macclesfield and Leek are underlined by the lower mortality rates in the silk manufacturing district of Coventry. In Coventry production was carried out in spacious modern factories with more efficient ventilation systems, which resulted in less overcrowding and a lower incidence of tuberculosis. This demonstrates that it was possible to manufacture silk without incurring the highest child tuberculosis mortality statistics of any of the manufacturing districts in nineteenth-century Britain, as was the case in Macclesfield, Leek and Congleton.

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