Health, Gender and the Household: Children's Growth in the Marcella Street Home, Boston, MA and the Ashford School, London, UK

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Abstract:

This paper measures the relative deprivation of children admitted to the Marcella Street Home (MSH) in Boston (1889-1898) and the West London School District (WLSD) (1908-1917) and compares the catch-up growth of boys and girls, a proxy for health and nutritional conditions before entering the institutions. The study yields two interesting results. First, children in the MSH who suffered from epidemic diseases such as measles and mumps did not have slower growth than their healthy counterparts. This suggests that more fatal, short-term diseases did not affect growth in the long run. Second, in both the MSH and the WLSD, girls experienced faster height gain relative to modern standards than boys. These results imply that girls were discriminated against in the allocation of household resources before entering these institutions. This finding is contradictory to household budget studies, which found no gender discrimination in household resources (Horrell and Oxley, 1999; Logan, 2007).

In neoclassical economic theory, individuals are assumed to be free to make decisions and reap the rewards or face the consequences of those decisions. However, both in historical and modern contexts, the household is often an intermediary between individuals and the economy. Individual's welfare is dependent on the household's income rather than each individual's income, and decisions about who works, who goes to school, etc. are made at the household level.[1] Historians are interested in how these decisions were made. For instance, did the male breadwinner family model give the father of the household inordinate power in making decisions and consuming resources? Did women and children sacrifice their own consumption to support the male breadwinner? Did members of the household that worked or had better labour market prospects receive more household resources than other with fewer opportunities? Or were resources allocated equally among the various members of the household? Because we seldom have detailed information about these decisions, historians and economists attempt to infer the decision-making process from the outcomes observed. Thus, they test whether men had higher living standards and better health than women and children, and they test whether boys were better off than girls.

This paper measures the relative deprivation of boys and girls in two government run schools in the late nineteenth and early twentieth centuries: the Marcella Street Home in Boston, Massachusetts (1889-98) and the Ashford School of the West London School District in London, England (1908-16). These data sources are particularly interesting because the children's heights and weights were recorded at entry and discharge from the schools, providing longitudinal growth information for many of the children. Thus, it is not only possible to measure the children's deprivation cross-sectionally as Steckel and others have done for other populations, but it is also possible to measure and compare the children's longitudinal growth while in the schools relative to modern standards.[2] This paper uses the differences in boys' and girls' catch-up growth in each school to argue that girls were unhealthy relative to boys before entering the schools.

The paper will proceed as follows: I will first briefly describe the literature on gender discrimination in health and resource allocation outcomes. Second, I will introduce growth curves, discuss the WHO 2006/7 height, weight, and BMI standards, and define catch-up growth. Next, I will describe the data sources and their representativeness. I will then proceed to establish that these children met the two preconditions for catch-up growth: their biometric measures were substantially below modern standards before entering the institutions and that entry into the institutions was a positive health intervention that could spark catch-up growth. Finally, I will establish that the children in both schools were experiencing catch-up growth relative to modern standards and that girls were experiencing faster catch-up growth than boys. There are three possible explanations for the greater catch-up growth in girls relative to boys: girls could have received better treatment in the schools, girls could have a greater natural propensity for catch-up growth, or girls could have been deprived relative to boys before entering the institutions. A close study of the conditions in the institutions and of the scientific literature on catch-up growth allows me to tentatively reject the first two possible explanations in favour of the third. Explaining why girls were in poorer health than boys is more difficult, but it seems reasonable to infer that this gender gap may have been caused by gender discrimination in the allocation of household resources

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[1] Horrell *et al.*, 'Measuring', pp. 94-97.

[2] Steckel, 'Peculiar Population'; Floud *et al.*, *Height*, pp. 163-182.

Gender Discrimination and Health in Nineteenth and Twentieth-century Britain and America

The influence of gender discrimination on health and resource allocation outcomes in the past has been measured historically in two main ways: through household budget studies and through anthropometric studies that measure differential influences of environmental factors on men and women's biological standard of living (height or BMI).[3] These indicators generally present a rosy picture of gender discrimination in Britain and the US relative to the more substantial differences that are commonly found in Asia. However, there is still evidence that women were not reaching equal outcomes to men in nineteenth and early twentieth century Britain and America.

Two studies, one for the US and the other for England, used the 'Cost of Living of Industrial Workers in the United States and Europe 1888-1890' survey conducted by the US Department of Labor on working class households to measure gender discrimination in the allocation of household resources. Horrell and Oxley found no clear and consistent pattern of gender bias in resource allocation in the household across their entire sample from England. There were differences in allocation by sector with girls slightly favoured (though the coefficients were insignificant) in households situated in textile regions, boys favoured in households in the metal-producing industry, and girls favoured in coal-mining families. Rather than confirming the simple hypothesis that children with the most labour market opportunities in the various sectors would be favoured with additional expenditure, they argued that three key elements seemed to be important in the allocation of resources: employment opportunities; inducements to try to retain valuable children in the household; and the relative worth of both children if both were or were not working.[4] Horrell and Oxley also found that girls received fewer calories and grams of protein in their diet daily than boys, but it was unclear whether this gap was larger than the biological difference in calories required caused by sexual dimorphism.[5] Using the portion of the Department of Labor survey collected in the US, Logan followed a similar methodology to Horrell and Oxley and came to a somewhat similar conclusion. Logan could not reject the efficient allocation of resources in the family; there was not bias against girls. However, he argues that equal allocation of resources did not mean that parents were acting in an egalitarian manner. Instead, parents allocated resources equally to boys and girls because 'the future higher earnings of boys were offset by their higher probability of leaving the household'.[6] Thus evidence on household resource allocation from late-nineteenth-century Britain and the US suggests that girls were not discriminated against. A caveat to these findings, however, is that most of the households surveyed in Britain and the US in the 1888-90 survey were from the wealthier parts of the working class, those employed full time in factories or large establishments.[7] Therefore, these households may not be strictly comparable to the poorest part of the working class.

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[3] BMI is body mass index and is equal to a person's mass in kilograms divided by the height squared in meters.
[4] Horrell and Oxley, 'Crust', pp. 513-4, 518.
[5] Horrell and Oxley, 'Crust', p. 510; Schneider, 'Real Wages'; FAO, 'Human', pp. 26-7.
[6] Logan, 'Family Allocation', pp. 20-23, 31 quote.
[7] Haines, 'Poverty', in Hershberg (ed.), *Philadelphia*, pp. 245-9; Horrell and Oxley, 'Crust', p. 499.

Another method of measuring gender discrimination in the allocation of household resources is to look carefully at the differences in the biological living standards (heights and BMI) of women and men. For instance, Horrell, Meredith and Oxley found that women in the Surrey House of Correction in Wandsworth, South London in the third quarter of the nineteenth century tended to gain weight while in prison while men lost weight. Likewise, women aged 25 and older had consistently lower BMIs than their male counterparts. These findings suggest that women were living under conditions of relative deprivation before entering the House of Correction.[8] Oxley and Meredith are in the process of conducting a similar study for the Paisley House of Correction near Glasgow but have found surprisingly different results. Women in Paisley (greater Glasgow) appear to have had higher BMIs than their male counterparts. They posit that women and children's greater labour market opportunities in Glasgow allowed them to bargain for a larger share of household resources.[9] These two studies on British prisoners suggest that woman did not always face discrimination and that bargaining models of resource allocation in the household may best describe the reality of Victorian Britain. To my knowledge there has not been similar anthropometric research conducted for the United States.

Thus, the literature paints a picture where gender discrimination is not particularly important for children in Britain and America but becomes quite important when understanding the health of adult men and women. This paper attempts to add more evidence on gender discrimination in childhood.

Modern Growth Standards and Catch-up Growth

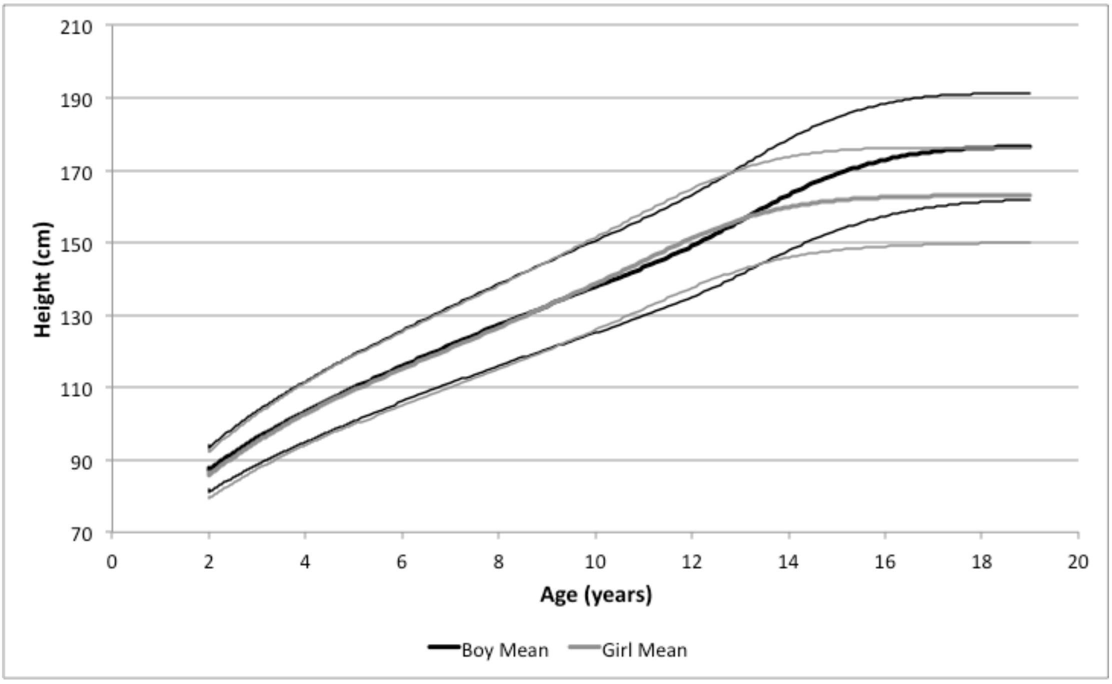
In order to compare the growth of children across countries, it is necessary to compare the children's anthropometric measures not only with contemporary populations but also with modern standards or references for the growth of children living under optimal conditions. In this paper, I will rely upon the World Health Organization (WHO)'s 2006 growth standards for preschool children ages 0-5 and the 2007 WHO growth references for preadolescent and adolescent children ages 5-19 in order to compare the relative deprivation of children and to understand how children's growth patterns were different historically than the ideal today. There is a long literature criticising previous growth standards and questioning whether growth references are useful at all, but the WHO 2006/7 references have been widely accepted around the world as a benchmark for rich, healthy children as well as poor, malnourished children.[10] Using the WHO standards also allows historians to compare the growth of the different populations across time because there is one common reference point.

[8] Horrell *et al.*, 'Measuring Misery', pp. 110-12, 114-5.

[9] Meredith and Oxley, 'Bread and Bone'.

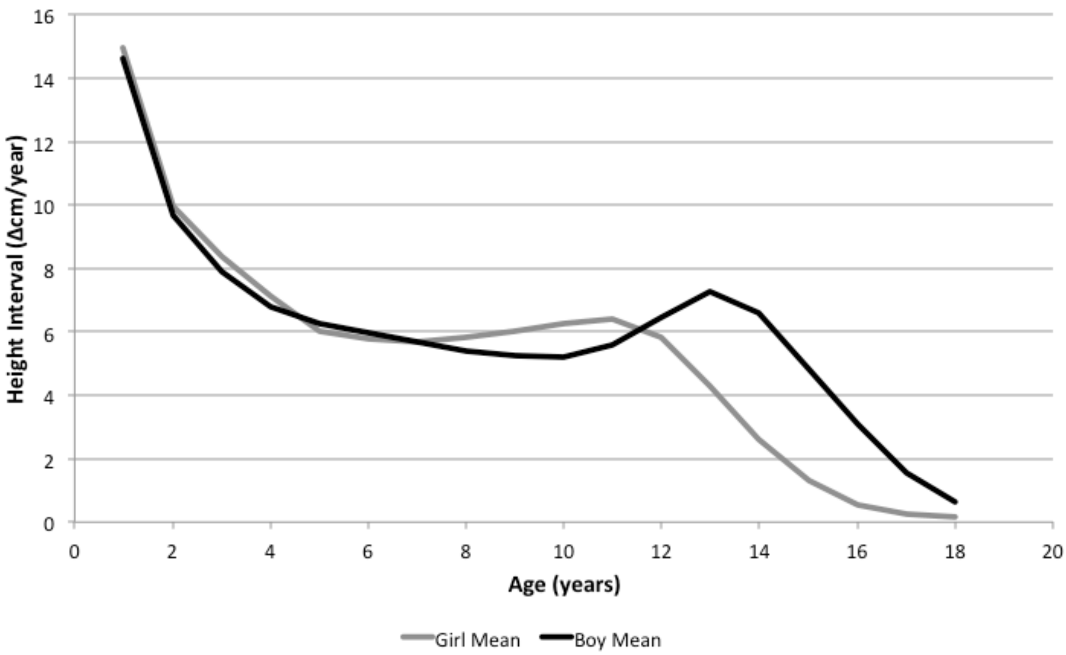
[10] The WHO 2006/7 growth references have been endorsed by the European Childhood Obesity Group, the International Pediatric Association, the UN Standing Committee on Nutrition, and the International Union of Nutrition Science. See also de Onis, 'Worldwide'; Butte *et al.*, 'Evaluation'; Wang *et al.*, 'Limitations'; Ulijaszek, 'International'; Eveleth and Tanner, *Worldwide*, pp.15-16.

Figure 1: WHO 2006/7 height for age standards for modern, healthy children. Mean heights with standard for +2 and -2 standard deviations around the mean.



Sources: de Onis *et al.*, 'Development'; WHO, 'WHO Child Growth Standards'; data drawn from http://www.who.int/growthref/en/.

Figure 2: Growth velocity (height intervals) for modern children according to the WHO 2006/7 growth references.

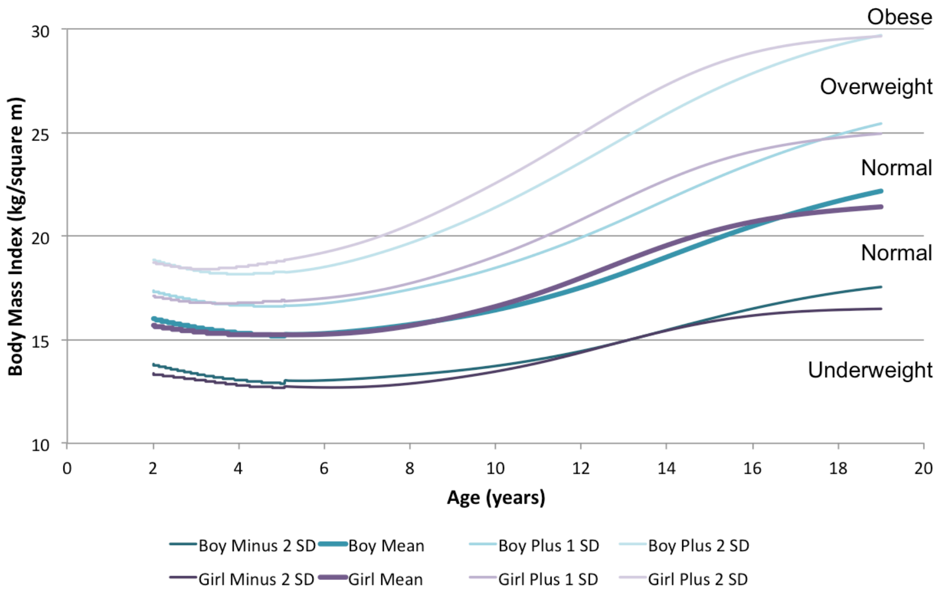


Sources: de Onis *et al.*, 'Development'; WHO, 'WHO Child Growth Standards'; data drawn from http://www.who.int/growthref/en/.

Figure 1 shows the WHO growth curve for height across the range of growing ages. It suggests that on average boys and girls have similar heights until girls begin to overtake boys during their pubertal growth spurt. The boys then overtake girls later on when they experience their own pubertal growth spurt. The timing of these growth spurts is more easily discerned when looking at a graph of height velocity over time, i.e. the annual rate of growth (Figure 2). From these figures it is clear that girls experience less of a pubertal growth spurt than a pubertal growth acceleration beginning around age seven, peaking around age eleven and declining swiftly thereafter. Boys have a later, more distinctive pubertal growth spurt, which begins around age ten, reaching its peak at age 13 and declining thereafter. The timing of these growth spurts tends to be delayed in malnourished populations and will be of interest when measuring catch-up growth later in the paper.

The WHO also defined weight for age standards for children up to age ten. After age ten the relationship between weight and age is no longer straightforward or useful as a measurement of deprivation. The curves generally increase over time, but otherwise have fewer problems with interpretation than the height for age standards. The BMI for age WHO growth references are more complicated. As can be seen in Figure 3, BMI for age standards decline until the age of 3.5 to five and then increase thereafter. The nadir of these curves is called the adiposity rebound, the point at which children begin putting on weight relative to height. The BMI standards are designed so that children with a BMI for age that is two standard deviations below the mean are considered underweight. Children between two standard deviations below the mean and one standard deviation above the mean are considered to have a normal BMI for age. Children between one standard deviation above the mean and two standard deviations above the mean are considered overweight, and children over two standard deviations above the mean are considered to be obese. The growth references for these three measures, then, will form the basis of the analysis conducted in the rest of the paper.

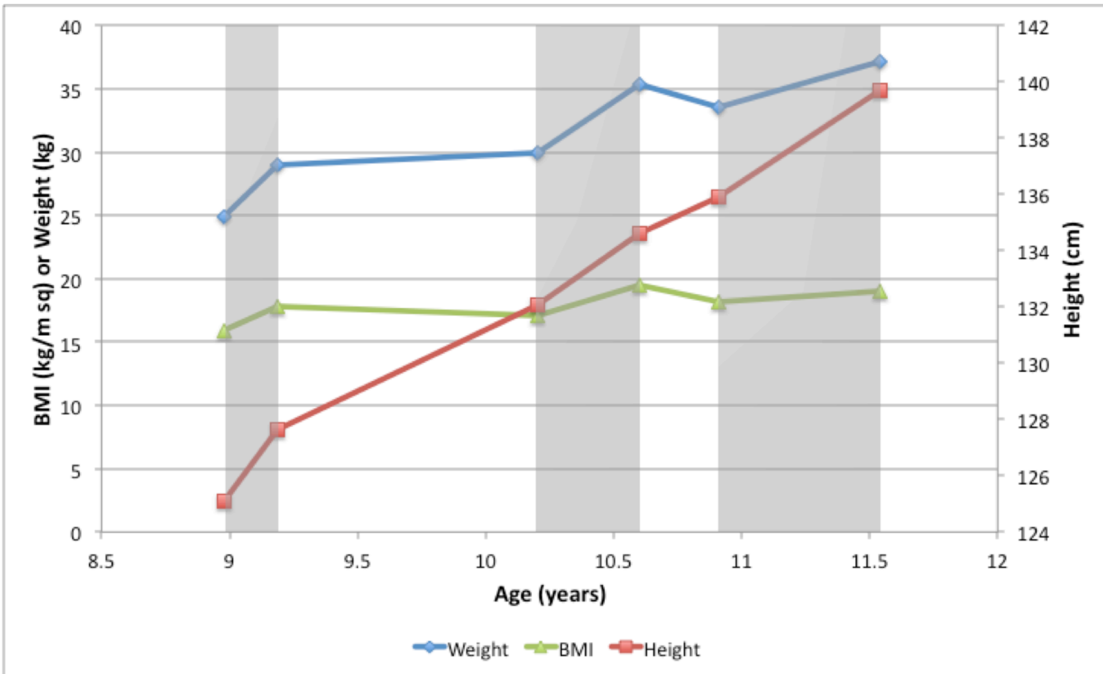
Figure 3: WHO 2006/7 BMI for age standards for modern, healthy children.



Sources: de Onis *et al.*, 'Development'; WHO, 'WHO Child Growth Standards'; data drawn from http://www.who.int/growthref/en/.

The focus of the paper is to measure the catch-up growth in terms of height, weight, and BMI experienced by children in the two schools. Catch-up growth is a period of faster than normal growth that occurs when children who are malnourished or exposed to chronic diseases are moved into a better nutritional and disease environment. Tanner hypothesized that the degree of catch-up growth would depend on the length of the intervention and on the relative deprivation the child experience before the intervention.[11]

Figure 4: Height, weight and BMI growth of Daniel O'Brien in the Marcella Street Home, Boston Massachusetts, 1892-4.

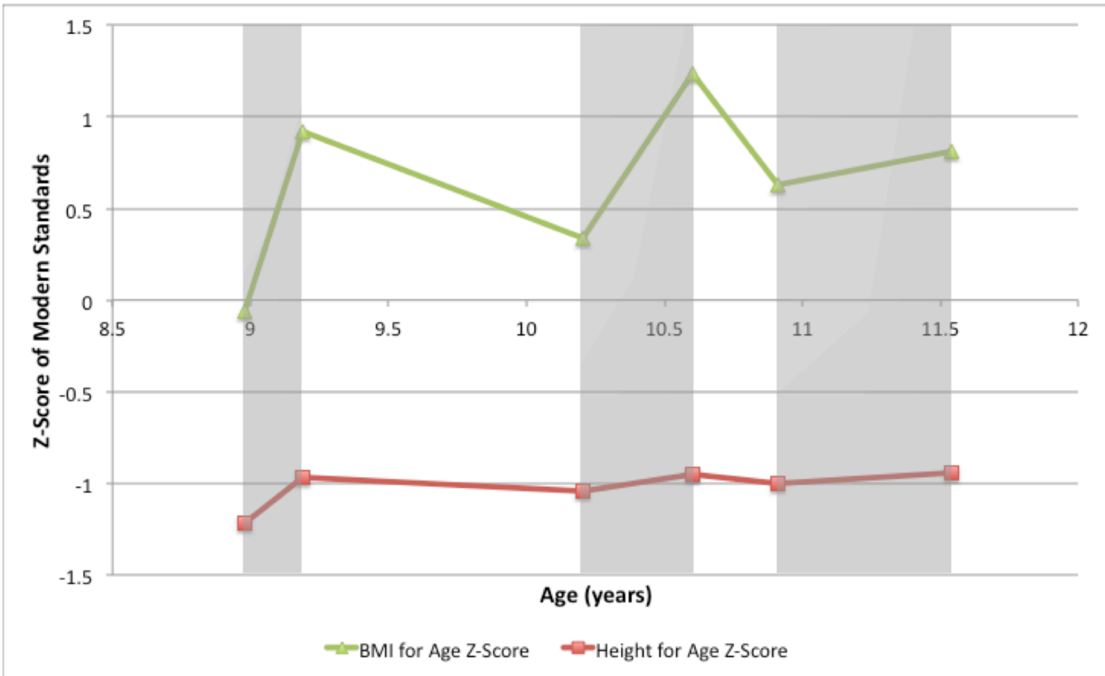


Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001.

Perhaps an example of a child in the Marcella Street Home will help to clarify a typical pattern of catch-up growth. As shown in Figure 4, Daniel O'Brien entered and left the Marcella Street Home three times between 1892 and 1894 (the grey shaded periods). When looking at his absolute height, weight, and BMI, Daniel gained weight while in the home and lost weight while outside of the home; the same is true of BMI. In terms of height, his height continued to increase across observable period, but his height growth was faster while in the home than outside of the home. All of this evidence suggests that Daniel was experiencing catch-up growth inside of the home. We can refine these patterns by expressing Daniel's growth in terms of z-scores of modern standards (Figure 5). Unfortunately, only his height and BMI for age z-scores can be calculated because weight for age z-scores do not extend beyond age ten. Expressing Daniel's growth in z-scores of modern standards makes the previous pattern even clearer. Daniel's height increased relative to modern standards while he was in the home and decreased while he was outside the home. The changes in BMI for age were even greater with Daniel experiencing nearly a one standard deviation of modern standards increase in BMI for age during his first stay in the Marcella Street Home. Daniel's figures show strong evidence that there could be catch-up growth among children in the Marcella Street Home and by extension in the Ashford School.

[11] Adair, 'Filipino', p. 1140-1141; Tanner, 'Catch-up'; Eveleth and Tanner, *Worldwide*, pp. 192-193.

Figure 5: Height and BMI growth as z-scores of modern stnadards of Daniel O'Brien in the Marcella Street Home, Boston Massachusetts, 1892-4.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001.

However, in order for catch-up growth to occur there are two key preconditions. First, the children must be substantially below modern standards before the catch-up period begins. Second, there must be a positive intervention that improves nutrition and decreases the disease load allowing catch-up growth to occur. The rest of the paper introduces the datasets, explains that these preconditions are met, establishes that children were catching-up to modern standards and measures differences in catch-up growth between boys and girls.

The Samples: Marcella Street Home

Before jumping into the methods and results of the paper, it is first necessary to provide some institutional context for the Marcella Street Home and the Ashford School and discuss the samples and representativeness. The Marcella Street Home was founded in 1876 in Roxbury, which had been annexed by Boston in 1868, on the western edge of Boston.[12] The Home was formed to house pauper and neglected boys who were housed at the Deer Island House of Reformation at the time. Pauper and neglected girls were incorporated into the home in 1881 after the construction of new buildings to accommodate them.[13] Boys and girls continued to be housed in separate departments throughout the life of the institution. The home had a school from its beginning where children were taught basic subjects, including reading and writing.

The heights and weights of children were not systematically recorded in the Marcella Street Home until 1889 and continued to be recorded until the institution closed in 1898 when all the children in the institution could be placed in foster homes.

[12] 'Twentieth Annual Report of the Board of Directors for Public Institutions', pp. 27-8, 66-7.
[13] 'Twenty-fifth Annual Report of the Board of Directors for Public Institutions', pp. 92-3.

The register includes the heights and/or weights of 475 children born between 1873 and 1898 with some children, like Daniel, entering and leaving the institution multiple times. In addition to their height and weight, it is necessary for the children's birthdate to be recorded in order to calculate z-scores for the children's anthropometric measurements relative to modern standards. Height and BMI z-scores could be calculated for 103 girls and 248 boys, but fewer than this number had their heights and weights recorded at entry and exit from the institution. The amount of time children remained in the home varied from zero days to 8.4 years with an average stay of 1.3 years.

The children were drawn from all over Boston, including South Boston and Roxbury. The Board of Visitors described the children in the home as follows in 1894:

> The population is supplied from two sources, — first, from the ranks of pauperism, and second, from the courts, which place children, found to be criminally neglected by their parents, under the legal guardianship of the city. Among the pauper children are a small number whose parents are obliged by unavoidable poverty to temporarily place them in the Home, and a very large number of unfortunate children born of dissolute, inebriate parents, who sacrifice even natural affection to better indulge an insatiable thirst for drink, while shirking the responsibility of caring for their offspring during the years of helplessness.[14]

The difference between pauper children and neglected children is key in this case because the one surviving register, the one used in this paper, only recorded the neglected children. There was likely a separate register for the pauper children, but it does not survive. This presents a real selection bias problem that is difficult to assess and overcome. Contemporary newspaper articles suggest that most children were sent to the institution because their parents were drunkards. For instance, the Boston Daily Advertiser reported July 15, 1881 that 'Catherine Mitchell was arrested and brought before the police court in Roxbury as a common drunkard. In her rooms were found her three children, five, three and a half and two years of age, *all intoxicated* [sic]. The society sent them to the Marcella-street home'.[15] A year later, the same newspaper published a speech given by Robert Treat Paine, Jr. in which he lamented the 'river' of neglected children that had to be sent to the home but acknowledged that 'perhaps they are more fortunate than those children who are still kept in a home where the father and mother both drink'.[16] The speech was given to a temperance society, so the stress on alcohol may be somewhat exaggerated, but it still highlights the nature of the neglect for which children were sentenced to the home.

The question, then, is how would neglected children compare to children in general and to the poor children that are represented in the Ashford School. This is a difficult question to answer because there is only limited information about the children and their parents. Pinpointing the social class of the children is difficult because the mother and father's occupations were not recorded in the register. However, there is information about the parents' immigration status. According to the Eleventh Census taken in 1890, 65.9 per cent of children under five had at least one parent born in a foreign country, 29.4 per cent had native born parents, 3.2 per cent were foreign born, and 1.5 per cent were black (Table 1).[17] In the Marcella Street

[14] 'Report of the Board of Visitors to the Public Institutions [1894]', p. 43.

[15] 'Cruelty to Children', *Boston Daily Advertiser*, 15 July 1881.

[16] 'A Public Meeting of the Citizen's League', *Boston Daily Advertiser*, 16 November 1882.

[17] Unfortunately, the data were not broken down further by age. I have followed the census in excluding the immigration status of black children's parents so that the number would be comparable. Billings, *Vital Statistics of Boston and Philadelphia*, pp. 116-17.

Home 62.8 per cent of white sentenced inmates had parents born outside the USA, 21.9 per cent had native-born parents, 9.4 per cent of white children were foreign-born, and 6.0 per cent were black. Testing these proportions against the 1890 census population data reveals that white children with native parents were significantly under-represented in the sample and white foreign-born children and black children were significantly over-represented in the sample because their respective t-values were larger than 1.97. Thus, it appears that the lower classes of immigrants and African Americans are over-represented among the sentenced children.

Table 1: Race and immigration status of the children's parents in the 1890 census for Boston and in the Marcella Street Home, 1889-1898.

	US Census 1890 (Boston children under 5)		Marcella Street Home		
	n	per cent	n	per cent	t-statistic
Native White Children with a Foreign-Born Parent	26,360	65.90%	241	62.76%	-1.27
Native White Children with Both Parents Native	11,742	29.35%	84	21.88%	-3.54
White Foreign-Born Children	1,294	3.23%	36	9.38%	4.12
Black Children	605	1.51%	23	5.99%	3.69
Total (for which immigration status or race is known)	40,001	100.00%	384	100.00%	

Notes: One sample proportion t-test. T-statistics above 1.97 or below -1.97 are statistically significant.

Sources: Billings, *Vital Statistics of Boston and Philadelphia*, pp. 116-17; City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001.

In the end, despite the selection bias in the Marcella Street Home sample, it seems unlikely that the selection would influence boys and girls differently. Likewise, there is no evidence in annual reports of the home or in other reports of the administration overseeing the home that girls were abused more harshly or more often than boys. If there were any discrimination in the allocation of household resources or in the general treatment of girls, this would be the remnant of attitudes of the larger society or perhaps class that the people were apart of rather than a specific result of the abuse.

The Samples: West London School District

The West London School District was founded in 1868 to accommodate poor children from the London parishes of Fulham, Hammersmith, Paddington, St. George's and later Westminster. The school was a residential school housing up to 800 students located in Ashford, Middlesex well outside of London. The school sat on a 70-acre site, which included six acres for the buildings of the school along with an attached farm. Boys and girls aged six and above were kept in separate wings of the main building at the school, and the rest of the younger children were housed in a separate building until November 1911 when the West London School District opened the Park School to house the younger children. There were two detached infirmaries, one for general diseases and the other for infectious diseases.[18] The board

[18] Monnington and Lampard, *Poor*, pp. 8-9; LMA, Signed Minutes of the Board of Management (SMBM) 1911, WLSD/27, pp. 177-8.

of managers employed a very large staff to supervise the children, educate them, maintain the buildings, and produce food on the farm.

The information on children resident in the Ashford School of the West London School District was drawn from the Medical Officer's Report Book, covering the years 1908 to 1916. Overall, 1,914 children born between 1892 and 1909 were collected from the register. Height and BMI z-scores could be calculated for 642 girls and 833 boys, 1475 in total, providing a larger and more robust sample than the Marcella Street Home. This sample decreased substantially when measuring longitudinal growth change though because not all children were measured at discharge. The children's ages varied from 0.64 to 18.31 years old with most falling between 5 and 15. The amount of time each child was resident in the Ashford school ranged from zero days to 8.98 years with an average of 1.46 years, slightly longer than the length of stay in the Marcella Street Home.

The children resident in the Ashford School were generally the children of workhouse inmates. The children were generally admitted into the school every two weeks, which meant that they could have been kept in a workhouse for several weeks before entry. Unfortunately, there is even less information about the children's parents than there was for the Marcella Street Home. The only data that was included in the Medical Officer's Report Book was the child's name, parish of residence, and biometric measurements. There is slightly more information about the children available in other registers collected by the Ashford School administration, but they do not include the most telling variables such as father's occupation and linking the two registers would require a substantial amount of time. Other studies on the workhouse though can provide a first glance at what the characteristics of these children were. Workhouse children tended to be orphans, deserted children, illegitimate children or children whose parents were also in the workhouse.[19] They were likely representative of the working poor of West London generally.

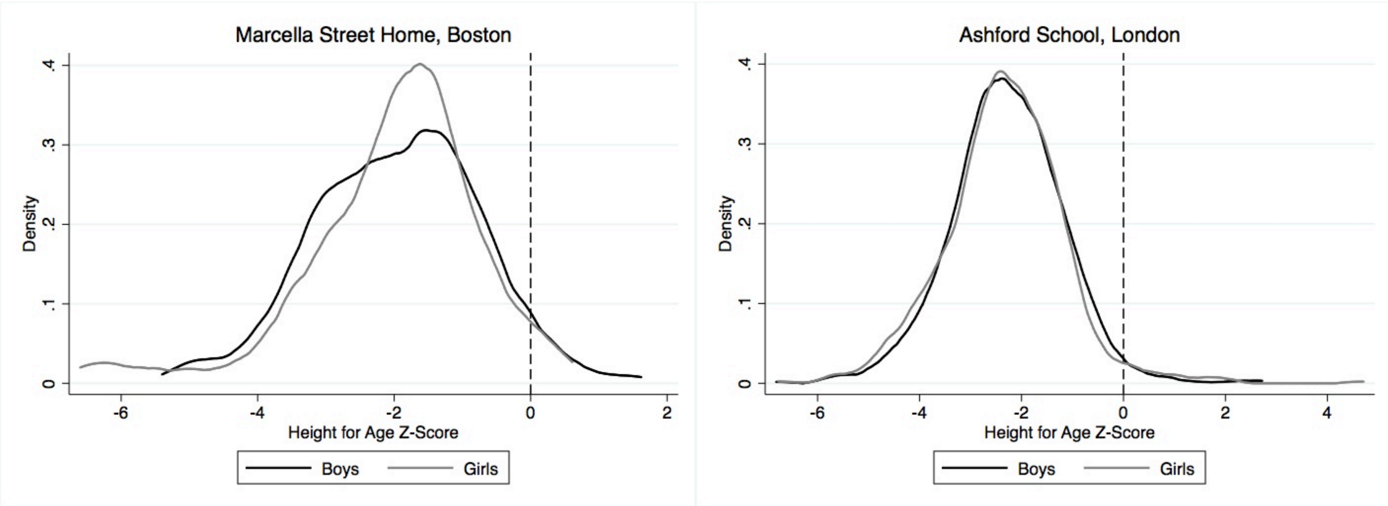
Preconditions for Catch-up Growth: Relative Deprivation of the Children

Before discussing the longitudinal growth of children in the Ashford School and Marcella Street home, it is first necessary to establish that the children in the two schools were capable of catch-up growth. The children's growth was different in two key aspects from modern populations: the absolute level of height or weight at any given year was lower and the children also seemed to follow a different growth.

Figure 6 shows the distributions of boys and girls heights at admission to both institutions as z-scores of modern standards. In both the Ashford School and the Marcella Street Home, the mean z-scores of children's heights for age were at or slightly below two standard deviations below the mean of modern standards. In other words, with a median z-score of -2.3, half of the children in the Ashford School had levels of height for age that would only occur in 1.07 per cent of a modern population. These children were clearly very deprived. The distributions of boys and girls were very similar in the Ashford School but were different in the Marcella Street Home. This difference in the distributions is puzzling and may be related to the different age profile of boys and girls in the Marcella Street Home.

[19] Wood, *Poverty*, pp. 98-100.

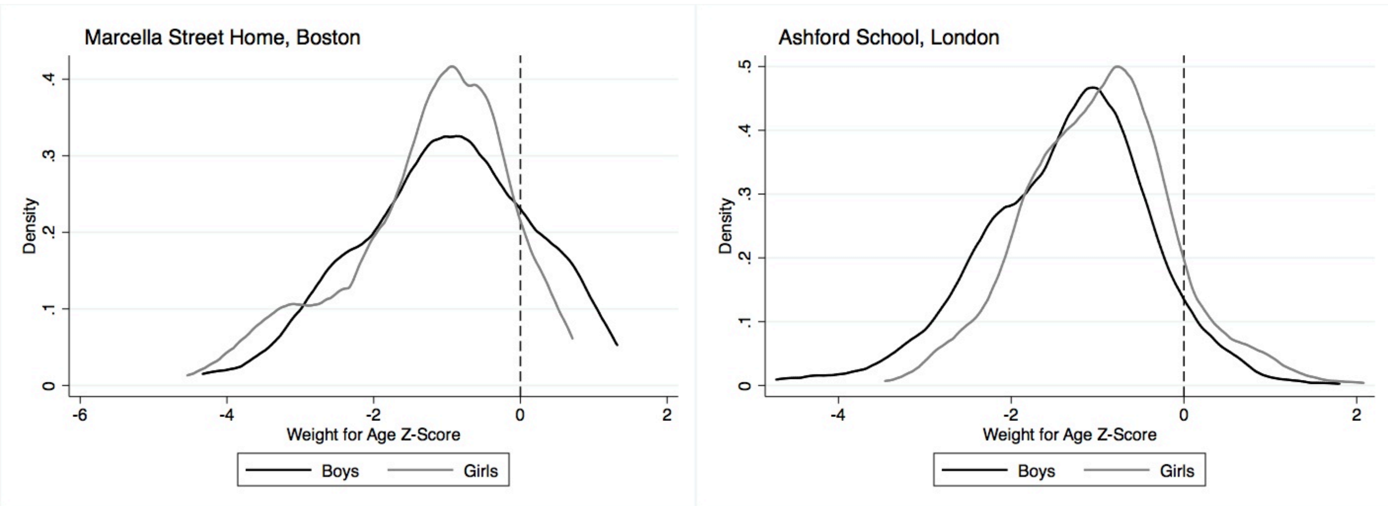
Figure 6: Height for age z-score distributions for children at admission to each school.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

The children were also behind modern standards in terms of weight for age, which again could only be calculated for children under 10 years old. Figure 7 displays the distribution of weight for age z-scores for boys and girls in both schools. For weight for age the means of the distributions were at or slightly below -1, suggesting that the children were better off in terms of weight for age than they were for height for age. However, they were still deprived relative to modern standards and can be expected to catch-up in weight for age z-scores.

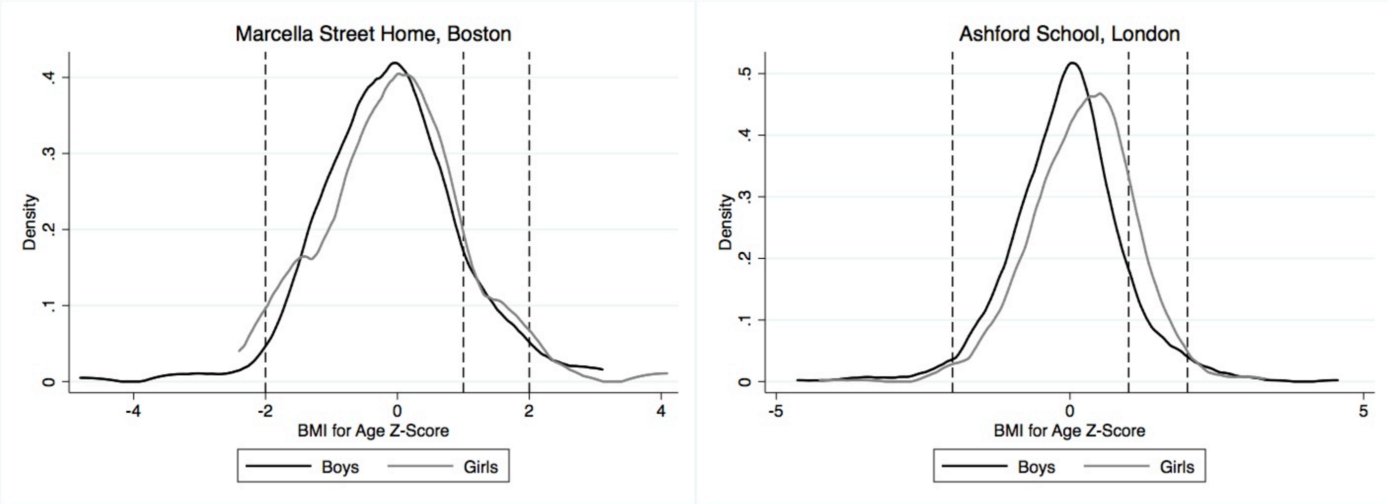
Figure 7: Weight for age z-score distributions for children at admission to each school.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Finally, in terms of BMI for age, the children in both schools were puzzlingly mostly in the normal BMI range between two standard deviations below the mean and one standard deviation above the mean (Figure 8). In addition, ten to fifteen per cent of children were classified as overweight or obese. The means of the distributions were close to zero. Thus, the evidence on BMI for age, if read naively, suggests that the children in both schools were healthy.

Figure 8: BMI for age z-score distributions for children at admission to each school.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

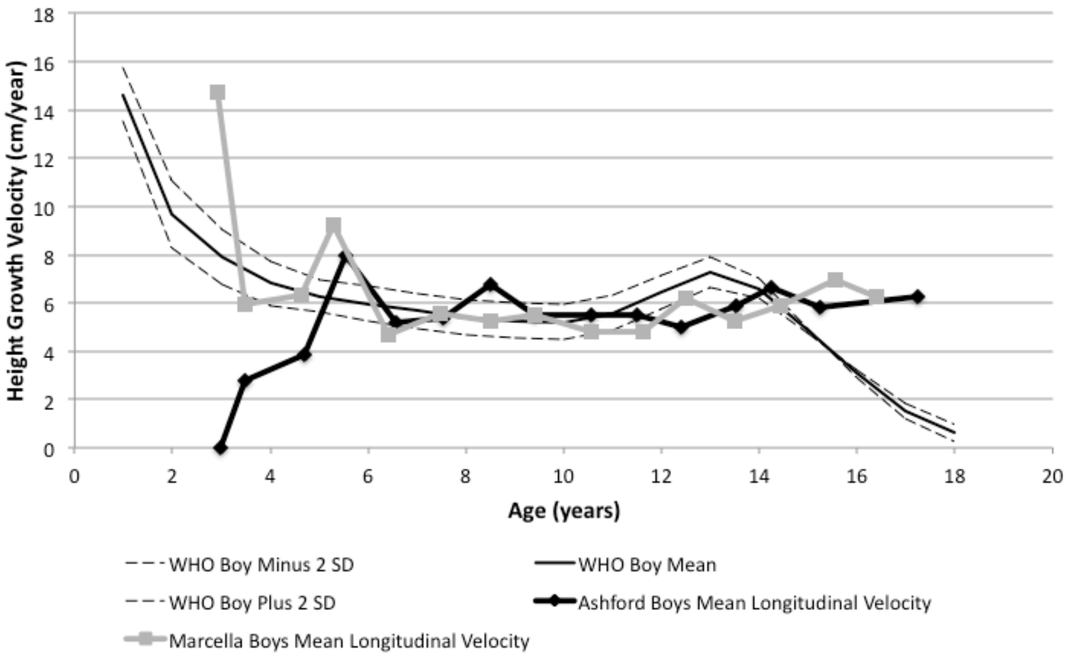
However, there are several reasons why this evidence should not be interpreted in such a straightforward manner. First, BMI (weight in kilograms divided by height in meters squared) is clearly not able to distinguish the composition of the body that leads to higher weight. Muscle and bone are denser than fat tissue, so if these children weighed more relative to their height because they had built up a lot of muscle tissue through working, a heavier BMI would not necessarily mean that they had the high body fat percentages that we now associate with overweight and obese individuals. Second, BMI is good measure of welfare for adults who have stopped growing because their heights, the denominator in the BMI calculation, do not change. Thus, changes in BMI only reflect changes in their mass, not their height. However, children grow in both measures. This is partially what gives the BMI growth curve its strange shape. If a child had a sudden spurt of growth, such as catch-up growth, their BMI would likely decrease even though their growth spurt would be a very good sign that they were in good health. Finally, Waaler's study of Norwegian longitudinal biometric and health records makes clear that mortality risk is not related to BMI in a two dimensional way. Instead, mortality is related in a three dimensional framework to both height and weight independently. Both shorter people and thinner people suffer a higher mortality risk relative to individuals of average height and weight independent of whether their BMI falls within the acceptable range.[20] Therefore, although these children appear to fall into the normal range for BMI, they are both stunted, two standard deviations below the modern mean height for age, and wasted, one standard deviation below the modern mean weight for age, which suggests that they will have a higher mortality risk and are therefore less healthy.

The children's height growth curve was also significantly different than their modern counterparts because the children had later pubertal growth spurts than modern children. In order to visualize these differences, it is helpful to study children's growth velocity rather than the nominal height levels at different ages. Figures 9 and 10 shows the longitudinal growth velocities of boys and girls at different ages in the Ashford School and Marcella Street Home. It is difficult to determine a precise peak age for the pubertal growth spurt, but it is clear that the

[20] Waaler, 'Height, Weight and Mortality'; Fogel, *Escape*, pp. 23-32; Floud *et al.*, *Changing Body*, pp. 57-72.

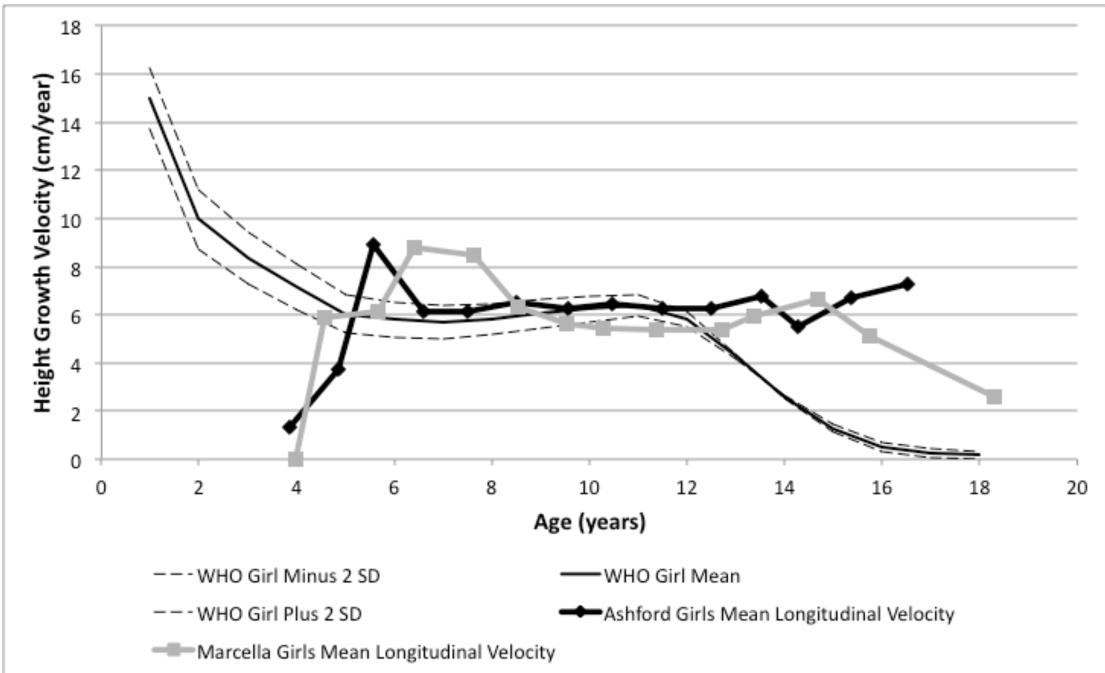
pubertal growth spurt took place in these children several years after the pubertal growth spurt in modern children.

Figure 9: Longitudinal growth velocity of boys in the Marcella Street Home, Boston and the Ashford School, London



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Figure 10: Longitudinal growth velocity of girls in the Marcella Street Home, Boston and the Ashford School, London



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

In conclusion, in terms of height and weight, the children in both schools were clearly deprived relative to modern standards. The later pubertal growth spurt in these children further supports their unhealthy state. Their BMI for age distribution was mostly in the normal range, but BMI for age is particularly difficult to interpret in children. Thus, it seems that, at least in some measurements, there was significant room for catch-up growth for children in both schools.

A Positive Health Intervention: The Marcella Street Home (1889-98)

Having shown that the children in both schools were deprived relative to modern standards, the first precondition for catch-up, I must now establish that the conditions in the both schools were substantially better than the conditions children were facing in either city before they entered the schools. If this were the case, then the children's entry into the institution could be considered a positive intervention that could spark catch-up growth. I will begin by describing the diet, hygiene and sanitary conditions in the Marcella Street Home before moving on to the Ashford School.

The diet in the Marcella Street Home was rather monotonous during the first half of the 1890s. It consisted of cocoa or milk and bread for breakfast; soup with some meat, bread, and potatoes for dinner, and cocoa or milk, bread and sometimes cheese for supper. This diet was scrutinized in November 1896 by an expert committee formed to investigate the dietaries in all of the public institutions managed by the city of Boston. The committee found the diet to be 'not well suited to growing children.'[21]The new superintendent, Michael J. Dwyer noted 'that the diet of the inmates, while apparently sufficient in quantity, was lacking in quality, variety and service'.[22] Dwyer immediately implemented some of the recommendations of the expert committee, and two published dietaries in 1897 and 1898 show improvement in a number of regards: molasses, cornmeal, and oatmeal were introduced at breakfast; vegetables and fruit became staples at dinner and meat portions may have increased as well; and cheese or butter and a dessert were added to the supper menu.[23]

Unfortunately, the quantity of the various foods given to the children was only reported once for November 1896, and it seems that the quantities reflect a dietary somewhere in between the old diet criticized by the expert committee and the implementation of the final dietary sometime in 1897. However, the November 1896 diet can be compared with the recommended diet put forth by the expert committee. Overall, the changes seem rather small. The committee recommended to increase the average daily consumption of eggs, butter, sugar, dried fruit, potatoes, and fresh vegetables, while they recommended a decrease in the consumption of milk (down 33 per cent). The amount of meat increased slightly, but it was already quite high in the older diet. It is not possible to recalculate the number of calories in the diet using modern and better techniques[24] because no recipes are given for the various foods. However, by the expert committee's own calculations based on Atwater factors, the value of protein and carbohydrates in the diet remained approximately the same,

[21] 'Annual Report of the Institutions Commissioner for the Year 1896-7', pp. 14-5 [P1040864].
[22] 'Annual Report of the Institutions Commissioner for the Year 1896-7', pp. 115 [P1040894].
[23] 'Annual Report of the Institutions Commissioner for the Year 1896-7', pp. 14-5, 116 [P1040864, P1040896]; 'Annual Report of the Children's Institutions Department for the Year 1897', pp. 20-1 [P1040926].
[24] See Schneider, 'Complicating', pp. 2-6.

while the amount fat increased from 55 to 77 grams per day and the total calories increased from 2,459 to 2,692 calories per day, a 9.5 per cent increase.[25] Anecdotal evidence that the quality of the flour purchased to make bread increased and that officers stopped skimming the milk so that the inmates and officers consumed the same bread and milk suggests that there was a marked increase in the quality of the diet.[26]

However, a diet of 2,459 calories before the dietary changes along with 1.4 pints of milk per day was not a bad diet, especially considering that the average age at entry into and discharge from the home was 9.04 and 10.34 respectively and very few children remained in the home beyond the age of 16. Boys and girls growing at modern height velocities do not require more than 2,459 calories per day until they are 12 and 14 respectively.[27] Thus, an average calorie intake across all children of 2,459 calories was undoubtedly more than they were receiving outside the home and was substantial enough to allow them to experience catch-up growth.

The Marcella Street Home seems to have been quite a sanitary institution given the standards of its time. Both superintendent A. B. Heath (in post 1885-94) and his successor William A. White (in post 1894-6) were physicians, and so they understood the importance of sanitation. The board of visitors had this to say of sanitary conditions in the home in 1894:

> Personal cleanliness is insisted upon. The children wash three times daily, and bathe frequently; clean towels are supplied for each washing, and good white soap provided. An admirable feature of the boys' washroom is the arrangement of hot and cold water faucets so placed that the children can wash under a stream of water, thus lessening the risk of communicating eye and skin diseases. The common institution practice which formally prevailed of sleeping in underclothes worn during the day has been amended for the girls, they being now supplied with night-gowns.[28]

Heath also proudly wrote in his report for 1892 that many children entered the home in deplorable condition with ophthalmia, chronic eczema, and other ailments but were nursed back to health in the hospital to be totally cured.[29]

There were further improvements in the Marcella Street Home in the later 1890s. First, the swill plant, which left a horrid odour around the home, was removed in 1897.[30] Second, Superintendent White oversaw the installation of new modern flush-toilets in the hospital and lower floors in the second half of 1895.[31] Finally, Superintendent Dwyer built additional toilets and new showers for the children in 1897.[32] Thus, it seems plausible that the Marcella Street Home provided a better sanitary environment and better food in larger quantities than the children would have

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[25] 'Annual Report of the Institutions Commissioner for the Year 1896-7', pp. 184-96 [P1040909-P1040915].

[26] A switch to higher fat content in milk and more refined flour would have made the increase in total calories even larger when accounting for digestion costs: Schneider, 'Complicating', pp. 2-5. 'Annual Report of the Children's Institutions Department for the Year 1897', p. 20 [P1040926]; 'Annual Report of the Institutions Commissioner for the Year 1896-7', p. 116 [P1040896].

[27] Schneider, 'Real Wages', p. 4; FAO, 'Human', pp. 26-7.

[28] 'Report of the Board of Visitors to the Public Institutions [1894]', p. 44.

[29] 'Annual Report of the Public Institutions Department, for the Year 1892', pp. 90-1 [P1020169].

[30] 'Annual Report of the Public Institutions Department, for the Year 1894', p. 21 [P1020250]; 'Annual Report of the Public Institutions Department, for the Year 1896', p. 120 [P1040898]; 'Annual Report of the Children's Institutions Department for the Year 1897', p. 15 [P1040923].

[31] 'Annual Report of the Public Institutions Department, for the Year 1895', p. 139 [P1020429].

[32] 'Annual Report of the Children's Institutions Department for the Year 1897', p. 15 [P1040923].

received in their own homes. In other words, the institution provided an opportunity for catch-up growth for the children in the home.

A Positive Health Intervention: The Ashford School, London (1908-16)

Conditions in the Ashford School were also substantially better for the pauper children there than the conditions they experienced before entering the home. The diet in the Ashford School was somewhat more varied than the Marcella Street Home but was still fairly monotonous. The children had the same food for breakfast every day, cocoa (made with milk), bread and margarine and had sultana bread for lunch. For dinner and supper there were different menus for older children aged seven to fourteen than the younger children aged three to seven. For the younger children dinner consisted of minced mutton three days per week, rice or bread pudding two days per week, and minced beef or soup one night per week each. These courses were supplemented with bread, baked or boiled potatoes and vegetables. For supper, the younger children received milk and either bread and margarine or sultana bread. The older children had more variety for dinner with main dishes such as baked mutton, baked beef, meat pie, raising pudding, and soup. They received bread with the meal if the main was not a pie, and also were given substantial amounts of potatoes and vegetables. For supper, the older children received bread with tea and treacle and cheese two to three times per week.[33] The children's diet was lacking, however, in fresh fruit with the children only receiving oranges once or twice a year as gifts.[34]

It is difficult to calculate the average caloric intake for the children because although simplified recipes are provided for the dishes, they are often vague about the ingredients. For instance, the ingredients for the school's soup were raw meat or shins of beef; split peas, lentils, or haricot beans; fresh vegetables; potatoes; and oatmeal.[35] Determining precise calorie levels for such vague food categories is problematic at best, but I have tried to use reasonable assumptions to come up with a level of calories per day per child. For the young children, their average calories per day varied between 1,641 and 1,930 kcal/day with an average of 1,708 kcal/day. The older children received more calories ranging from 1,896 kcal/day to 2,874 kcal/day with a mean of 2,404 kcal/day.[36] These ranges were probably wide in part because of the imprecise nature of the calorie calculations, but there also did appear to be days where the children were given more or less food. With regard to grams of protein in the diet, the younger children received 59 grams of protein on average per day, while the older children received 70 grams of protein per day. This level of calories and protein was more than would be required for the children's growth. Boys in modern populations do not need 1,700 kcal/day until they are seven, so all of the children in the younger group had plenty of calories. For the older boys, boys in modern populations do not need 2,400 kcal/day until age twelve. However, this did not mean that the boys above age twelve were not getting the calories they required. The food servers almost certainly did not give children age seven the same amount of food as

[33] LMA, Dietary Tables, Recipes, etc., Dietary of 1909, WLSD/468.

[34] LMA, SMBM 1908, WLSD/24/2, p. 42; LMA, SMBM 1910, WLSD/25, p. 63; LMA, SMBM 1911, WLSD/27, p. 36; LMA, SMBM 1913, WLSD/28/1, p. 81; LMA, SMBM 1914, WLSD/28/2, p. 55; LMA, SMBM 1915, WLSD/28/3, pp. 18, 72.

[35] LMA, Dietary Tables, Recipes, etc., Recipes for Dietary of 1909, WLSD/468.

[36] The maximum values in the category of older children were driven by the high calorie content of the raisin pudding. I checked these calculations and believe them to be correct, but even if they are excluded the average energy available only fall to 2,216 kcal/day.

the fifteen-year-olds. Thus, it is safe to imagine that the food was allocated in the home such that all of the children had more than enough calories for growth and to lead a healthy life.

Sanitary conditions in the Ashford School changed quite dramatically during period studied in this paper (1908-16). At the beginning of the period, most of the toilet facilities were earth closets.[37] However, major sewage improvements were undertaken between September 1909 and January 1911. During this period nearly all of the earth closets were converted to water closets and the drains and general sewage system were improved.[38] The board of managers and medical officer were initially displeased with the works because the pump that moved the sewage through the system was blocked several times in February, March and April of 1910. The medical officer even grumpily reported that 'the ground near the Boys' Playgound has been recently saturated with sewage'.[39] However, after a temporary pump was installed and the system was modified, the insanitary conditions seemed to subside.[40] There were minor problems with the service thereafter,[41] but by September 1915 the system was reported to be working 'in a most satisfactory manner'.[42] In addition, aside from the brief period at the beginning of 1910 described above, there were no references of children becoming ill because of poor sanitation. Likewise, children were very rarely sent to the infirmary because of diarrhoea, and there were no reported cases of typhoid during the period studied.

The superintendent and board of managers were also concerned to maintain the quality of the water supply. The water in the school was drawn from a deep well and was often tested for signs of impurity.[43] The water tanks were also regularly cleaned and improved over the years.[44] There were occasional problems with the pump that pulled the water out of the deep well, but these were generally solved quickly, and the managers could also draw water from private utilities if necessary.[45] However, like nearly all buildings in this period, there was lead piping throughout the building, which likely diminished the cognitive ability and general health of all in the institution.[46]

The staff in the school also enforced personal hygiene. Bathing took place once a week for the older children but more frequently for the younger children age six and below.[47] The children also washed their hands with soap frequently in primitive sinks.[48] Monnington and Lampard, the authors of a late nineteenth-century

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37 LMA, SMBM 1908, WLSD/24/2, pp. 78-85.
38 LMA, SMBM 1909, WLSD/24/3, p. 126; LMA, SMBM 1911, WLSD/27, p. 43; LMA, SMBM 1908, WLSD/24/2, pp. 78-85.
39 LMA, SMBM 1910, WLSD/25, p. 75.
40 LMA, SMBM 1911, WLSD/27, p. 43.
41 LMA, SMBM 1912, WLSD/26, pp. 69-71.
42 LMA, SMBM 1915, WLSD/28/3, p. 158.
43 Monnington and Lampard, *Poor*, p. 8; LMA, SMBM 1907, WLSD/24/1, pp. 47, 56-7, 141; LMA, SMBM 1910, WLSD/25, p. 63; LMA, SMBM 1911, WLSD/27, p. 2; LMA, SMBM 1913, WLSD/28/1, p. 101; LMA, SMBM 1914, WLSD/28/2, pp. 14, 32.
44 LMA, SMBM 1907, WLSD/24/1, pp. 56-7; LMA, SMBM 1910, WLSD/25, pp. 18, 21-2; LMA, SMBM 1914, WLSD/28/2, p. 114; LMA, SMBM 1915, WLSD/28/3, pp. 40, 97, 193; LMA, SMBM 1916, WLSD/29/1, p. 51.
45 LMA, SMBM 1909, WLSD/24/3, pp. 24, 42, 49.
46 LMA, SMBM 1908, WLSD/24/2, p. 169; LMA, SMBM 1910, WLSD/25, p. 192; Shukla *et al.*, 'Fetal'.
47 LMA, SMBM 1912, WLSD/26, p. 216.
48 LMA, SMBM 1907, WLSD/24/1, p. 100; LMA, SMBM 1909, WLSD/24/3, p. 97; LMA, SMBM 1910, WLSD/25, p. 81; Monnington and Lampard, *Poor*, pp. 10-11.

study of the Poor Law Schools, mentioned that the children had clean towels three times a week, but this cannot be corroborated for the later period in the minutes.[49] The older children were also provided with a toothbrush and brushing powder to brush their teeth regularly.[50] In conclusion, even though the personal hygiene of the children was not as good as might be expected by modern standards, it seems highly unlikely that children of the working poor would have had such good conditions in their homes.

The children's health and growth could also have been affected by the environmental conditions in the home. Keeping the school warm in the winter was a particular problem at the beginning of the period studied here.[51] In January 1908, the superintendent reported that 'the Children's Rooms were very cold that morning, and at 10 o'clock he could not get a temperature of 50 deg. in many of the rooms'.[52] A new heating system was implemented in 1907 and 1908 and refined periodically thereafter, which though not entirely effective, was a great improvement on prior conditions where the school buildings had not been heated; in February 1908, the medical officer reported that the previous year there were 51 children being treated for chilblains in February compared to one case that year.[53]

Despite some problems in implementing the new sewage system and keeping the school warm, it seems likely that the children's access to good nutrition, hygiene and healthcare was better in the Ashford School than in the children's homes in London. This again provides clear evidence for a positive intervention which could have spurred catch-up growth.

Catch-up Growth in the Ashford School and Marcella Street Home

Having established that children in the Marcella Street Home and Ashford School were deprived relative to modern standards and that admission into either school was a positive nutritional and environmental intervention, we can now turn to measuring the children's longitudinal growth while in each school to see whether they were catching up to or falling behind modern standards while in each school. The measure of catch-up growth employed in this paper is the change in WHO z-score while the child was in the institution, the z-score at discharge minus the z-score at admission.[54] If the change in z-score was negative, then the child fell behind modern standards during his/her time in the school. If the change in z-score was zero, then the child would have continued growing at the same rate as predicted by modern standards, though likely at lower level. Finally, if the change in z-score was positive, then the child would have grown faster than modern growth standards, catching up relative to the mean.

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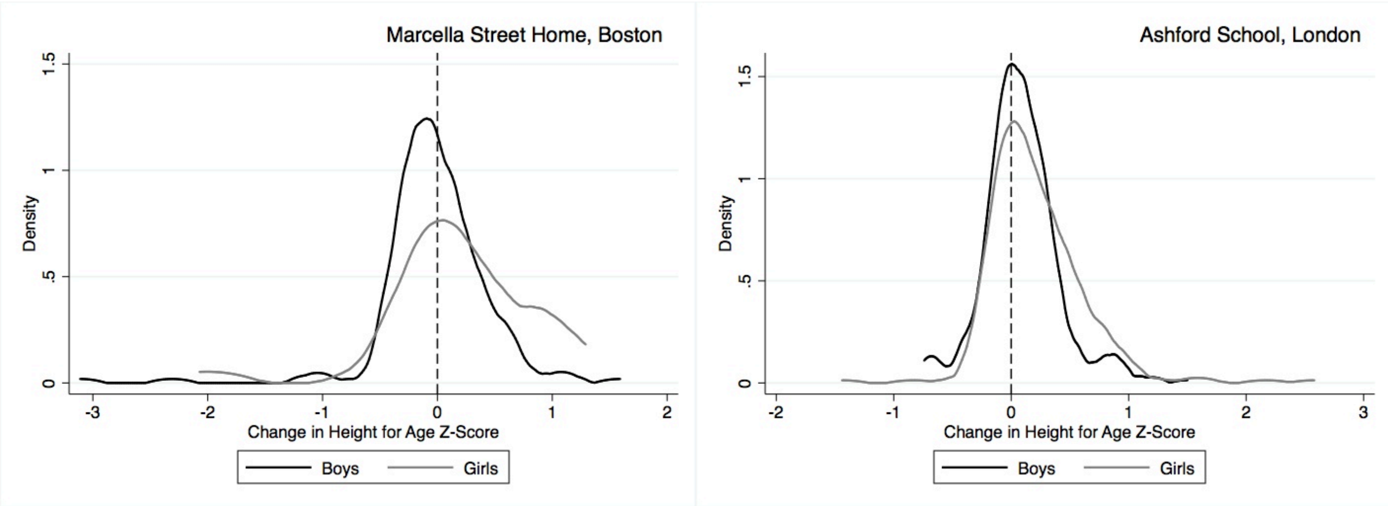
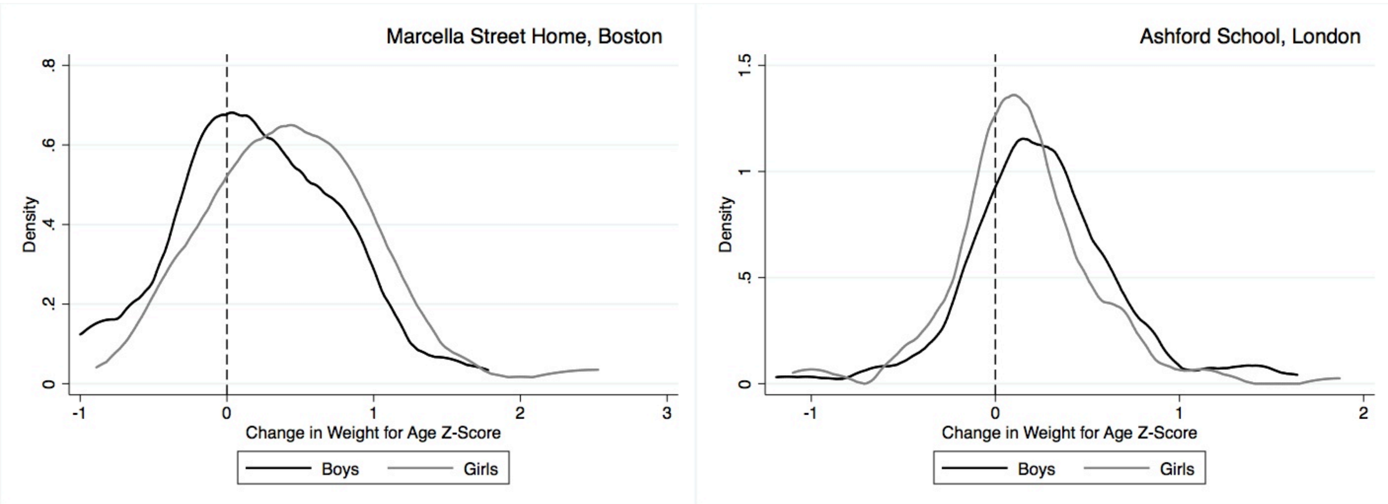
[49] Monnington and Lampard, *Poor*, p. 10.
[50] LMA, SMBM 1911, WLSD/27, p. 212; Monnington and Lampard, *Poor*, p. 10.
[51] LMA, SMBM 1907, WLSD/24/1, p. 15; LMA, SMBM 1908, WLSD/24/2, p. 2; LMA, SMBM 1909, WLSD/24/3, p. 26; LMA, SMBM 1910, WLSD/25, pp. 5-6; LMA, SMBM 1911, WLSD/27, p. 3; LMA, SMBM 1916, WLSD/29/1, p. 103.
[52] LMA, SMBM 1908, WLSD/24/2, p. 2.
[53] Chilblains is 'an inflammatory swelling produced by exposure to cold' *OED Online*; LMA, SMBM 1908, WLSD/24/2, p. 26.
[54] It is not necessary to include a time element in this variable because the children's z-scores for height, weight and BMI are age dependent.

Figure 11: Kernel density plot of change in height for age z-score for boys and girls in the Marcella Street Home, Boston and the Ashford School, London.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Figure 12: Kernel density plot of change in weight for age z-score for boys and girls in the Marcella Street Home, Boston and the Ashford School, London.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Figures 11-13 display the kernel density plots of the change in z-score for height, weight and BMI. For z-score change in height, girls seem to have had an advantage in both schools relative to boys. The right side of the girls' distribution extended farther and a greater number of girls experienced z-score growth rather than z-score decline. Table 2 reports the means and standard deviations of the distributions along with the results of a one sample t-test comparing each distribution to zero. The mean change in height z-score was significantly positive for both boys and girls in the Ashford School, but was only significant in girls in the Marcella Street Home. Height z-score change for Boys in the Marcella Street Home was not statistically different than zero partially because there were a number of children sentenced for truancy that were probably not from the same underprivileged background: this is explained in detail later. The change in weight z-score distributions were less clear cut than the change in height z-score distributions. In the Marcella Street Home, girls (under 10) appeared to have had an advantage in weight gain whereas the opposite was true in the Ashford School. These findings are corroborated by the means of each of the distributions, and all of the means were statistically different than zero. Finally, for change in BMI z-score, the results were again mixed. Girls seemed to have an advantage in the Marcella Street Home whereas boys seemed to have a slight advantage in the Ashford School. Again, the means of the distributions corroborate this evidence, but only girls in the Marcella Street Home and boys in the Ashford School had change in BMI z-scores that were significantly different than zero. However, we cannot be certain of these results without controlling for a number of potentially confounding factors in a multiple regression framework.

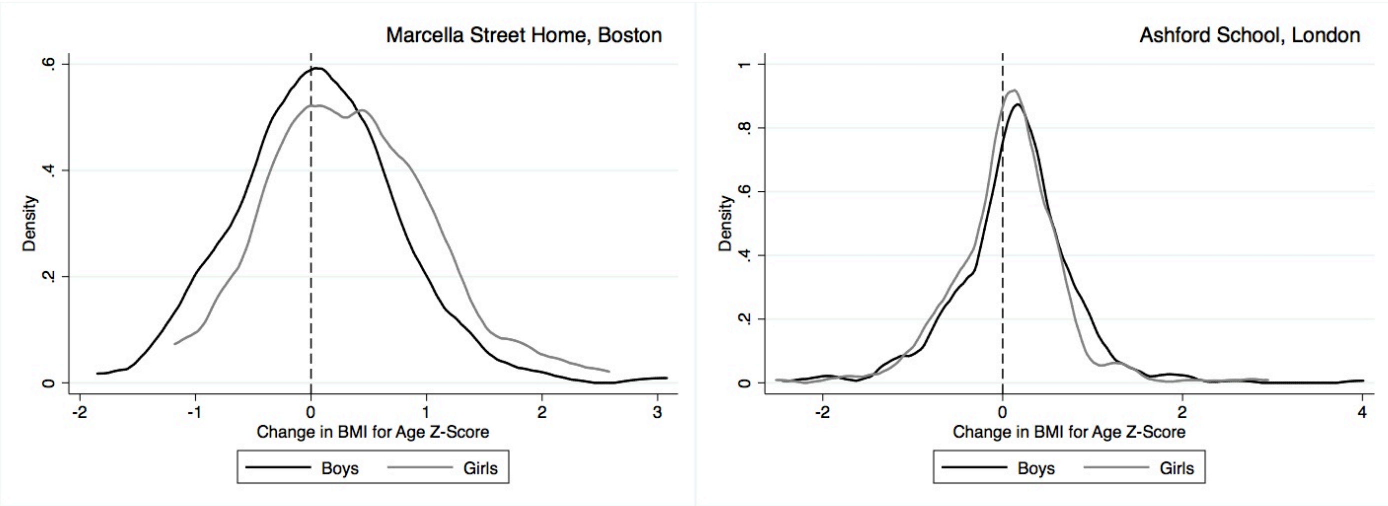
Table 2: Descriptive statistics of change in height for age, weight for age, and BMI for age z-scores for boys and girls in the Marcella Street Home, Boston and the Ashford School, London.

	Marcella Street Home, Boston		Ashford School, London	
	Boys	Girls	Boys	Girls
Change in Height for Age Z-Score				
mean	-0.017	0.193	0.087	0.213
standard deviation	0.469	0.644	0.315	0.408
one sample t-test (ref = 0)	-0.48	2.22	5.10	8.28
Change in Weight for Age Z-Score				
mean	0.201	0.450	0.255	0.153
standard deviation	0.584	0.618	0.425	0.389
one sample t-test (ref = 0)	2.38	4.30	7.96	4.59
Change in BMI for Age Z-Score				
mean	0.058	0.333	0.141	0.058
standard deviation	0.707	0.736	0.654	0.604
one sample t-test (ref = 0)	1.11	3.59	4.25	1.62

Notes: One sample t-tests tested whether each measure of catch-up growth was significantly different than zero. Sample sizes varied across the distributions, but in t-values above 2 were significant at the 95 per cent level.

Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Figure 13: Kernel density plot of change in BMI for age z-score for boys and girls in the Marcella Street Home, Boston and the Ashford School, London.



Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001; London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Gender Differences in Catch-up Growth

Although it is clear that children were experiencing catch-up growth in terms of height and weight in both schools, these calculations are much more complicated than may first appear because, as discussed above, children in the past rarely grew at the growth curve represented by modern standards. The children in the Marcella Street Home and Ashford School had a later pubertal growth spurt than the children used to represent modern standards. Thus, as shown in Figure 10, girls in both the Marcella Street Home and Ashford School were growing much faster after the age of 13 than the modern standards would suggest. This higher velocity would give the girls the appearance of experiencing rapid catch-up growth when really they were just reaching the pubertal growth spurt at a later age. This effect is especially problematic since there were few boys in the schools past the age of 16 or 17, so many boys had not completed their pubertal growth spurt by the time they left the school. Thus, it is necessary to measure catch-up growth in a multiple regression framework where we can control for the differences between the historical and modern growth curves. These problems were not as strong for weight for age z-scores, which tended to gradually increase over time and could not be calculated for children over the age of ten. However, as mentioned above, historical BMI growth curves were slightly different than modern BMI growth curves, so it is again necessary to control for differences between the two curves.

Thus, in order to measure differences in catch-up growth between different groups within each institution, the change in z-score is held as the dependent variable in the OLS regression analysis and a number of independent variables are introduced to measure between group differences. First, the amount of time that each child spent in the institution is included to control for any differences between children who may have stayed in the institution longer than others. In addition, the height and BMI z-scores at admission are included to control for regression to the mean and the relationship between weight and growth. Regression to the mean is a well-known phenomenon whereby extreme initial measurements of random variables are likely to move closer to the average of the distribution of the variable. In this case, children who were very tall or very short for their age when measured at admission would be more likely to be at a point closer to the average when next measured. I think the case for regression to mean here is somewhat weak because growth is not a random process but is arguably programmed based on environmental conditions during foetal and early life development. However, many of the scientific studies of catch-up growth include the height at initial measurement to control for regression to the mean, so I have included it in the regressions since it seems to be best practice.[55]

Including BMI in the height change regression and height in the BMI change regression controls for the relationship between height and weight. For instance, children often put on some fat before their pubertal growth spurt in order to help provide energy for growth. Thus, one would expect children with higher BMIs upon admission to the schools to grow in height faster than children with lower BMIs. Another important variable is whether each child had siblings present in the school. Hatton and Martin have found that children with more siblings were shorter than their counterparts with fewer siblings because larger families had fewer resources to allocate to each child, so it is important to attempt to control for this effect.[56] Unfortunately, this is rather difficult because the only information about each child's family size is the number of children from a particular family that entered the institution together. There is no guarantee, however, that the children entered with all of their siblings, and there were too many children entering the schools alone for them to have been only children. The only way to verify each child's family size would be to link the school registers with census data, which would be very time consuming. Because of these problems, family size was entered into the regression as a dummy variable where children with siblings in the school with them were assigned a one and all others were assigned a zero. Finally, a dummy variable representing sex was included in the regressions to see if boys and girls experienced significantly different catch-up growth.

There were also several variables specific to the Marcella Street Home that could be included in the regression analysis because the Marcella Street Home register was more detailed than the Ashford School Medical Officer's Report Book. The medical officer reported whether each child's father and mother were alive, so dummy variables were entered into the regressions to control for the effect of having a dead father or mother. It is also necessary to include a dummy variable in the Marcella Street Home regressions for children who entered the school to serve sentences of truancy. Truant children were normally sent to a separate reformatory in Boston, but from October 1895 to June 1896, 123 boys and 6 girls were admitted to the Marcella Street Home to serve sentences for truancy. These boys and girls came from a different background than their counterparts and were also significantly older than the average child entering the school. It was therefore necessary to include a dummy variable to capture the potential differences between truant inmates and regular inmates in the regressions. Finally, for some of the children in the home, the medical officer reported when they became sick with contagious diseases. These diseases included whooping cough (pertussis), chicken pox, mumps, measles, and scarlet fever. Thus, we can measure whether children who suffered from one or more of these diseases had slower growth over their time in the home than the other children who did not suffer from these diseases.

[55] Walker *et al.*, 'Early Childhood', p. 3019.
[56] Hatton and Martin, 'Effects'; Hatton and Martin, 'Fertility'.

The final set of variables included in the regressions for both schools attempted to capture the differences in the growth curves between modern and historical populations. In order to control for these effects, the sex dummy variable was interacted with age dummy variables, one for each one-year increment. These interactions, therefore, control for any systematic z-score change that occurs for all children of a certain age and sex. Therefore, the coefficients on the interacted age dummies for girls from age twelve onward are all positive because girls in the past reached their pubertal growth spurt at a later age than modern girls and grew at a faster rate than would be predicted solely by modern standards. There were also some adjustments for boys, though these were not as dramatic. The age for the interaction was measured in two ways: by the age of each child upon discharge from the institution and by the middle age of each child between entry and discharge from the institution. These two ways of measuring the effect of the age of a child on z-score change capture potentially different aspects of growth. The discharge age attributes any systematic catch-up growth (z-score change) to the final age assuming that the child was likely growing at a faster rate at the end of the period rather than at the beginning. The middle age assigns the growth to the midpoint of the child's stay assuming that this is a better measure.

Simple OLS regressions were run for each school independently for each measure of growth, change in height, weight, and BMI z-score. It was not possible to estimate fixed effects regressions for the data because the children were not measured at regular intervals, making the panel structure unbalanced. In addition, I am more interested in the differences in catch-up growth between different children, the time invariant change, than the specific factors affecting children's growth that were changing while the children were in the institution. Unfortunately, there is not enough day-to-day evidence on the conditions in each school to be able to measure such small fluctuations. All of the regressions exclude a very small number of 'outlier' children who either had negative height growth or grew at ridiculously high rates. These data points were verified in the original sources and most likely represent measurement or arithmetic error in the original sources. A number of children in both schools also entered and left the institution more than once. Because the purpose of measuring the velocity of catch-up growth is to make inferences about the nutritional and environmental conditions that children were facing before they entered the home, it was important to exclude children's additional entries into the school. Finally, the medical officers recording heights in the institutions often rounded to the nearest half inch, so children who were in the schools for only a short period of time were more likely to be reported as not having grown at all or having grown at an unrealistically high rate. These rounding errors would have skewed the results, so children who only stayed in the institutions for less than 30 days were excluded from the change in height for age z-score regressions.

Table 3: Change in height z-score for age regressions for the Marcella Street Home, Boston, MA.

Dependent: Change in Height Z-Score	1	2	3	4	5
Model	OLS	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust	Robust
N	228	228	228	228	228
Constant	-0.091	0.037	0.156	0.077	0.181
	(-0.71)	(0.26)	(1.23)	(0.62)	(1.65)
Length of Stay (years)	0.001	-0.051	-0.042	-0.025	-0.035
	(0.03)	(-1.06)	(-0.57)	(-0.52)	(-0.45)
Height for Age Z-Score at Admission	-0.191***	-0.189***		-0.166***	
	(-5.22)	(-4.97)		(-4.48)	
BMI for Age Z-Score at Admission	0.130**	0.175***		0.172***	
	(2.56)	(3.14)		(3.02)	
Sibling present in School	-0.067	-0.016	-0.016	-0.031	0.008
	(-0.82)	(-0.20)	(-0.16)	(-0.43)	(0.11)
Child's Father Dead	0.146	0.130	0.117	0.093	0.105
	(1.64)	(1.41)	(1.19)	(1.07)	(1.16)
Child's Mother Dead	0.082	-0.012	-0.073	-0.013	-0.090
	(0.98)	(-0.14)	(-0.95)	(-0.17)	(-1.23)
Disease Dummy	-0.255	-0.128	-0.071	-0.080	0.025
	(-1.14)	(-0.76)	(-0.29)	(-0.43)	(0.10)
Sentenced for Truancy	-0.251***	-0.269***	-0.212***	-0.269***	-0.199***
	(-3.79)	(-3.65)	(-3.33)	(-3.74)	(-3.17)
Sex Dummy (1 = male)	-0.113	-0.645***	-0.315***	-0.665***	-0.780***
	(-1.26)	(-9.33)	(-7.30)	(-3.72)	(-4.68)
Age and Sex Interactions:					
Discharge Age		X	X		
Middle Age in Institution				X	X
R-square	0.30	0.49	0.26	0.47	0.27
F-statistic	6.73				

Unstandardized coefficients with t-statistics in parentheses. * denotes significance on the 10 per cent level; ** denotes signficance on the 5 per cent level; *** denotes significance on the 1 per cent level. Excluding outliers, entries after the first, and lengths of stay less than one month.

Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001.

Table 4: Change in height z-score for age regressions for the Ashford School, West London School District, London, UK.

Dependent: Change in Height Z-Score	1	2	3	4	5
Model	OLS	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust	Robust
N	594	594	594	594	594
Length of Stay (years)	0.069***	0.067***	0.074***	0.068***	0.074***
	(4.63)	(4.39)	(5.12)	(4.62)	(5.05)
Height for Age Z-Score at Admission	-0.058***	-0.037**		-0.038**	
	(-3.31)	(-2.52)		(-2.48)	
BMI for Age Z-Score at Admission	0.029	0.041**		0.042**	
	(1.65)	(2.05)		(2.08)	
Sibling present in School	0.015	0.015	0.024	0.010	0.019
	(0.52)	(0.55)	(0.89)	(0.38)	(0.69)
Sex Dummy (1 = male)	-0.107***	-0.795***	-0.708***	-0.567	-0.472
	(-3.57)	(-10.82)	(-8.52)	(-1.46)	(-1.18)
Age and Sex Interactions:					
Discharge Age		X	X		
Middle Age in Institution				X	X
Parish/Poor Law Union Dummies	X	X	X	X	X
R-square	0.12	0.29	0.27	0.29	0.27
F-statistic	7.05**				

Unstandardized coefficients with t-statistics in parentheses. * denotes significance on the 10 per cent level; ** denotes signficance on the 5 per cent level; *** denotes significance on the 1 per cent level. Excluding outliers, entries after the first, and lengths of stay less than one month.

Sources: London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Beginning with the change in height z-score regressions, there are a number of interesting factors that help to explain children's longitudinal growth during the late nineteenth and early twentieth century (Tables 3 and 4). In both the Marcella Street Home and the Ashford School, there was regression to the mean in children's growth. Children who entered the institutions tall for their age experienced slower growth than their shorter counterparts. In addition, children who entered with higher BMI for age z-scores experienced greater growth than those children who entered with little excess fat that could be converted to energy for growth. This fat build-up is especially important before the pubertal growth spurt. These are both expected results. However, the effect of the length of time each child spent in the institutions was different in the Marcella Street Home than in the Ashford School. In the Ashford School, the longer children remained in the school the more they caught up relative to modern growth standards whereas in the Marcella Street Home there was no significant relationship between the length of time a child spent in the school and their catch-up growth. Whether a child had siblings in the school with him/her or not was also not statistically significant on either side of the Atlantic. Thus, there were no measureable growth benefits for children who had siblings to help them and protect them in the school, and family size does not seem to have played a strong role in catch-up growth. These results should not be overemphasized, however, since the number of children entering the institution together was at best a weak proxy for family size.

For the variables specific to the Marcella Street Home, children's orphan status did not significantly affect the children's catch-up growth. In addition, children who suffered from an acute infectious disease in the home did not experience significantly slower catch-up growth than the other children in the home. This result suggests that these short, acute diseases were probably less of a problem for long-run growth than chronic diseases such as diarrhoea, though the effect of these chronic diseases cannot be explicitly tested here. Finally, children sentenced for truancy experienced slower catch-up growth than the other children in the home. This result confirms that the children sentenced for truancy were slightly better off than the rest of the children in the home.

Finally, the most interesting result is that in both schools girls experienced faster catch-up growth than boys controlling for all the other variables mentioned above and for age-specific differences between modern and historical growth curves. The sex dummy coefficient did become insignificant in the Ashford School regressions when controlling for the middle age of each child interactions, but the coefficients remained negative and of a similar magnitude. This result and its implications will be discussed more thoroughly in the next section of the chapter.

The change in weight for age z-score and BMI for age z-score regressions were less enlightening with few significant and consistent results across the regressions (Tables 5-8). In both cases regression to the mean was still significant and negative in the regressions. Children who entered the institution with higher BMI for age z-scores were less likely to catch-up in terms of weight for age or BMI for age. Aside from weight for age in the Marcella Street Home, children who entered the institutions with taller height for age z-scores experienced greater weight and BMI growth than their shorter counterparts. In the Ashford School, there was a negative and significant relationship between the length of stay in the school and the change in

Table 5: Change in weight z-score for age regressions for the Marcella Street Home, Boston, MA.

Dependent: Change in Weight Z-Score	1	2	3	4	5
Model	OLS	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust	Robust
N	73	73	81	73	81
Constant	-0.062	1.242*	0.231	-0.143	2.417***
	(-0.36)	(1.99)	(0.28)	(-0.39)	(9.51)
Length of Stay (years)	0.038	-0.009	0.128*	0.044	0.118*
	(0.55)	(-0.14)	(1.93)	(0.71)	(1.68)
Height for Age Z-Score at Admission	-0.156***	-0.173***		-0.176***	
	(-3.86)	(-4.12)		(-3.92)	
BMI for Age Z-Score at Admission	-0.272***	-0.300***		-0.287***	
	(-4.29)	(-5.20)		(-4.57)	
Sibling present in School	0.218	0.093	0.051	0.125	0.195
	(1.61)	(0.61)	(0.21)	(1.00)	(1.06)
Child's Father Dead	-0.329	-0.642*	-0.259	-0.657**	-0.432
	(-1.11)	(-1.80)	(-0.41)	(-2.50)	(-1.00)
Child's Mother Dead	-0.000	0.154	-0.360	0.151	-0.370
	(-0.00)	(0.72)	(-1.23)	(0.67)	(-1.10)
Disease Dummy	-0.149	-0.191	0.083	-0.134	-0.110
	(-0.96)	(-1.28)	(0.31)	(-0.82)	(-0.46)
Sentenced for Truancy	0.110	0.185	0.108	0.138	0.055
	(0.57)	(0.70)	(0.33)	(0.56)	(0.19)
Sex Dummy (1 = male)	-0.060	0.544	-0.510	-0.008	-0.410
	(-0.58)	(1.39)	(-0.76)	(-0.04)	(-1.43)
Age and Sex Interactions:					
Discharge Age		X	X		
Middle Age in Institution				X	X
R-square	0.40	0.57	0.30	0.53	0.39
F-statistic	4.52				

Unstandardized coefficients with t-statistics in parentheses. * denotes significance on the 10 per cent level; ** denotes signficance on the 5 per cent level; *** denotes significance on the 1 per cent level. Excluding outliers and entries after the first but including lengths of stay less than one month.

Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001.

Table 6: Change in weight z-score for age regressions for the Ashford School, West London School District, London, UK.

Dependent: Change in Weight Z-Score	1	2	3	4	5
Model	OLS	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust	Robust
N	310	310	310	310	310
Length of Stay (years)	-0.075**	-0.076**	-0.120***	-0.076**	-0.097***
	(-2.49)	(-2.40)	(-3.47)	(-2.51)	(-2.91)
Height for Age Z-Score at Admission	0.115***	0.115***		0.099***	
	(3.20)	(3.13)		(2.61)	
BMI for Age Z-Score at Admission	-0.235***	-0.225***		-0.209***	
	(-5.62)	(-4.85)		(-4.40)	
Sibling present in School	0.041	0.039	0.039	0.040	0.046
	(0.91)	(0.88)	(0.81)	(0.89)	(0.93)
Sex Dummy (1 = male)	0.047	0.545***	0.562***	0.312	0.365
	(1.09)	(8.52)	(7.94)	(0.77)	(0.93)
Age and Sex Interactions:					
Discharge Age		X	X		
Middle Age in Institution				X	X
Parish/Poor Law Union Dummies	X	X	X	X	X
R-square	0.19	0.23	0.14	0.25	0.17
F-statistic	7.65**				

Unstandardized coefficients with t-statistics in parentheses. * denotes significance on the 10 per cent level; ** denotes signficance on the 5 per cent level; *** denotes significance on the 1 per cent level. Excluding outliers and entries after the first but including lengths of stay less than one month.

Sources: London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

Table 7: Change in BMI z-score for age regressions for the Marcella Street Home, Boston, MA.

Dependent: Change in BMI Z-Score	1	2	3	4	5
Model	OLS	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust	Robust
N	246	246	246	246	246
Constant	0.412***	-0.716**	-0.133	1.945**	0.801
	(3.01)	(-2.33)	(-0.44)	(2.36)	(1.00)
Length of Stay (years)	-0.097**	-0.039	-0.050	-0.064*	-0.028
	(-2.49)	(-0.97)	(-0.76)	(-1.74)	(-0.44)
Height for Age Z-Score at Admission	0.080**	0.097**		0.104***	
	(2.25)	(2.24)		(2.78)	
BMI for Age Z-Score at Admission	-0.317***	-0.413***		-0.377***	
	(-6.07)	(-7.39)		(-6.11)	
Sibling present in School	0.172*	0.033	0.056	0.084	0.063
	(1.74)	(0.31)	(0.47)	(0.80)	(0.57)
Child's Father Dead	0.013	0.040	0.050	0.021	0.014
	(0.12)	(0.37)	(0.39)	(0.18)	(0.11)
Child's Mother Dead	-0.052	-0.039	-0.030	0.006	0.038
	(-0.46)	(-0.33)	(-0.21)	(0.04)	(0.25)
Disease Dummy	0.214	0.045	-0.039	0.018	-0.131
	(0.92)	(0.21)	(-0.13)	(0.09)	(-0.45)
Sentenced for Truancy	-0.155	-0.022	-0.176	-0.037	-0.171
	(-1.52)	(-0.18)	(-1.47)	(-0.33)	(-1.56)
Sex Dummy (1 = male)	-0.180*	1.178***	0.609***	-0.678***	-0.358
	(-1.81)	(4.83)	(2.70)	(-2.84)	(-1.57)
Age and Sex Interactions:					
Discharge Age		X	X		
Middle Age in Institution				X	X
R-square	0.23	0.38	0.17	0.34	0.15
F-statistic	6.54				

Unstandardized coefficients with t-statistics in parentheses. * denotes significance on the 10 per cent level; ** denotes signficance on the 5 per cent level; *** denotes significance on the 1 per cent level. Excluding outliers and entries after the first but including lengths of stay less than one month.

Sources: City of Boston Archives, Marcella Street Home Register of Sentenced Inmates, 1877-1898, 8503.001.

Table 8: Change in BMI z-score for age regressions for the Ashford School, West London School District, London, UK.

Dependent: Change in BMI Z-Score	1	2	3	4	5
Model	OLS	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust	Robust
N	672	672	672	672	672
Length of Stay (years)	-0.201***	-0.163***	-0.220***	-0.184***	-0.213***
	(-9.46)	(-7.34)	(-10.41)	(-8.98)	(-9.65)
Height for Age Z-Score at Admission	0.032*	0.026		0.027	
	(1.69)	(1.24)		(1.41)	
BMI for Age Z-Score at Admission	-0.229***	-0.302***		-0.299***	
	(-6.58)	(-6.82)		(-6.58)	
Sibling present in School	0.051	0.076*	0.048	0.069	0.041
	(1.15)	(1.83)	(1.06)	(1.54)	(0.85)
Sex Dummy (1 = male)	0.020	0.140	-0.384	-1.012*	-1.150**
	(0.48)	(0.33)	(-1.36)	(-1.68)	(-2.06)
Age and Sex Interactions:					
Discharge Age		X	X		
Middle Age in Institution				X	X
Parish/Poor Law Union Dummies	X	X	X	X	X
R-square	0.26	0.34	0.22	0.32	.21
F-statistic	20.96***				

Unstandardized coefficients with t-statistics in parentheses. * denotes significance on the 10 per cent level; ** denotes signficance on the 5 per cent level; *** denotes significance on the 1 per cent level. Excluding outliers and entries after the first but including lengths of stay less than one month.

Sources: London Metropolitan Archives, West London School District, Medical Officer's Report Book, WLSD/435.

weight and BMI for age z-score. This result is puzzling because it suggests that children in the institution longer were falling behind modern standards for weight and BMI. The magnitude of the coefficients and their significance is also consistent when including different age dummy and sex dummy interactions, so it cannot be explained by the age structure of the population in the school. Finally, unlike height catch-up, there were no consistent findings of gender bias in weight for age or BMI for age z-score growth. The most plausible explanation for these weak results is that because children were likely in the workhouse or court system for a couple of weeks before entering the schools and weight gain takes place much faster than growth in height, the children may have already put on significant weight before entering institutions, skewing the figures reported by the medical officers.

Explaining Gender Differences in Catch-up Growth

As mentioned above, girls experienced faster catch-up growth in terms of height in both the Marcella Street Home and the Ashford School, but there was not a similar effect for weight or BMI growth. There are three possible explanations for the faster catch-up growth in girls than in boys in these institutions: girls could have been treated better than boys in the institutions; girls could have a greater natural propensity for catch-up growth than boys; and finally, girls could have been deprived relative to boys suggesting that girls were discriminated against in the allocation of household resources before entering the institutions. I will deal with each of these possibilities in turn.

There is not strong evidence that girls were better treated in the Ashford School and Marcella Street Home than boys. It is true that the boys' dormitories tended to be more crowded and messier than the girls' dormitories, but this does not necessarily translate into worse conditions. Levels of work appeared to have been similar if not entirely comparable. The only potential place where girls may have been given an advantage over boys is in their diet. In the dietaries reported by both schools, there was no distinction between the amount of food given to girls and boys.[57] Because the average boy requires more energy than a girl of the same age, if girls and boys were given the same amount of food, this would be a disadvantage for boys relative to girls.[58] However, the dietary for the Marcella Street Home did not break down the portion size by the age of children, and it seems unlikely that children of all ages were given the same portions of food. Likewise, even though the Ashford School dietary did break down the dietary into two age categories, there were reports that the girls did not always finish their portions.[59] Thus, any difference in food portion size can probably be explained away by the fact that girls were probably given less food in the first place and consumed less of what they were given than boys. We can then tentatively reject the better treatment of girls as an explanation for their greater catch-up growth.

[57] LMA, Dietary Tables, Recipes, etc., Dietary of 1909, WLSD/468; 'Annual Report of the Institutions Commissioner for the Year 1896-7', pp. 184-96 [P1040909-P1040915].
[58] Schneider, 'Real Wages', p. 3; FAO, 'Human', pp. 26-27.
[59] LMA, SMBM 1915, WLSD/28/3, p. 6.

The second explanation that girls have a greater natural propensity for catch-up growth is more difficult to analyse for two reasons. First, there are very few, if any, truly experimental studies of catch-up growth because purposely starving children to measure their catch-up growth is unethical. Thus, scientists and development economists have had to measure catch-up growth by conducting interventions on children who were deprived. The second difficulty with testing whether girls have a greater natural propensity for catch-up growth is that most of the catch-up growth studies do not include gender explicitly in their analysis. Many of the papers measuring catch-up growth do not distinguish between boys and girls in their analysis at all.[60] I have only found one paper that explicitly measures gender in a catch-up growth framework, which measures the catch-up growth of children without an intervention in the Philippines. Adair found that girls had a higher propensity for catch-up growth, defined as moving from a height below -2 standard deviations of modern standards at age 2 to above that level at age 8.5. However, Adair found that boys and post-menarchal girls were more likely to experience catch-up growth between the ages 8.5 and 12 than girls. She also makes no claim that the patterns observed reflect the natural propensity of one gender over the other most likely because it would be difficult to separate this natural propensity from societal factors that could explain the difference. The fact that Adair's study measures non-intervention catch-up rather than the intervention catch-up measured in this paper also limits the comparability of the results.[61] Therefore, again, I believe it is possible to tentatively reject the hypothesis that the measured difference in boys' and girls' catch-up growth in the Ashford School and Marcella Street Home is caused by girls' greater natural propensity for catch-up growth.

Thus, we can tentatively accept the third explanation that girls were deprived relative to boys before entering the schools. Finding a reason for this relative deprivation, on the other hand, is more difficult, and unfortunately is somewhat untestable with the data studied here. However, following other historians it seems plausible to infer that these differences in deprivation reflect discrimination against girls in the allocation of household resources. It is the most parsimonious explanation for these differences. These gender differences in health are compatible with bargaining models of household allocation where children who brought resources to the family received a larger share of the resources. Boys in late nineteenth-century Boston and early twentieth-century London had more labour market opportunities, possibly explaining their relative health compared to girls. However, it is also possible that ideology played a role; households may have valued their girls less than their boys for non-economic reasons. Unfortunately, I cannot distinguish between these two mechanisms of allocation.

However, this finding of discrimination contradicts the household budget literature, which found no gender discrimination in resource allocation among upper working class families in Britain and the US.[62] The results drawn from these two methodologies may have been different because this paper studies the children of the working poor whereas the household budget studies reflect the expenditures of higher status workers. Families closer to poverty were likely forced to make harder decisions when allocating household resources to their children.

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[60] Walker *et al.*, 'Early'; Perez-Escamilla and Pollit, 'Growth'; etc.
[61] Adair, 'Filipino Children', pp. 1143-1144.
[62] Horrell and Oxley, 'Crust'; Logan, 'Family Allocation'.