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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 is the first to use the individual level, longitudinal catch-up growth of boys and girls in a historical population to measure their relative deprivation. The data is drawn from two government schools, the Marcella Street Home (MSH) in Boston, MA (1889-1898) and the Ashford School of the West London School District (1908-1917). The paper provides an extensive discussion of the two schools including the characteristics of the children, their representativeness, selection bias and the conditions in each school. It also provides a methodological introduction to measuring children's longitudinal catch-up growth. After analysing the catch-up growth of boys and girls in the schools, it finds that there were no substantial differences between the catch-up growth by gender. Thus, these data suggest that there were not major health disparities between boys and girls in late nineteenth century America and early twentieth century Britain.

Running Head: Health, Gender and the Household

JEL Codes: N31, N33, I14, J13, J16

Keywords: Children's growth, gender inequality, health history

1. Introduction

After Amartya Sen published his famous piece "More Than 100 Million Women are Missing" in the New York Review of Books in 1990, there was a substantial increase in attention both from the general public and from economists on analysing gender disparities in health, education and life chances. Economists uncovered a complex array of economic and cultural factors that influenced male bias and naturally economic historians wondered whether these same types of factors promoted male bias in Western Europe and North America when countries in these regions were at a similar level of development. Economic historians analysed excess female mortality, household budgets and children and adult heights and generally found mixed and weak results without the unambiguous bias found in some developing countries today (McNay, Humphries and Klasen, 2005; Horrell and Oxley, 1999; Harris, 2008).

Despite the substantial focus on gender disparities in health in the literature, it is often difficult to find good indicators to measure these differences. The most common indicator, excess female mortality, only reveals cases of extreme difference between the genders, which may not be representative of the health of the entire population. Most household budget surveys only report consumption and expenditure at the household level, making it difficult to analyse the consumption of children. Finally, even interpreting children's growth and final adult height can be difficult since it is not easy to distinguish between gender disparities and sexual dimorphism, the natural physical differences between men and women. Thus, this paper introduces a new methodology to test for gender disparities in health: analysing children's longitudinal catch-up growth.

In this paper I take advantage of a natural experiment that occurred when poor children were placed in residential schools. Because the children's heights and weights were measured at entry to and discharge from the schools, it is possible to measure their longitudinal growth to determine whether they were catching up or falling behind relative to modern standards of child growth. The children's catch-up growth would be determined by two factors: their level of deprivation before entering the institution and the difference in conditions between the children's home environment and the school environment. We would not expect a child who was growing well above modern standards and had a good environment at home to experience significant catch-up growth when entering an institution that also provided a good environment. However, children would experience catch-up growth if they were deprived at home and then entered an institution that provided them with better nutrition, hygiene and medical treatment. Thus, gender differences in catch-up growth would reveal gender disparities in health between boys and girls.

I use data collected from two schools, the Marcella Street Home (1889-1898) in Boston, Massachusetts and the Ashford School of the West London School District (1908-1917) in London. Both schools were operated by the local municipality and were founded to educate poor and neglected children. The Marcella Street Home was on the outskirts of Boston in the growing area of Roxbury, whereas the Ashford School was well outside London on a large site that included a working farm. In general, the children were representative of poorer working class families, who had fallen on hardship and either ended up in the workhouse in London or in front of the courts in Boston. The selection mechanism of children into the schools is not entirely clear, especially differential selection by gender, but I test a number of hypotheses and conclude that although there may have been some selection by gender, it would not have influenced the relative health of boys and girls before entering the home.

Measuring the children's catch-up growth is actually rather difficult: children grow at different rates across their growing years, and boys and girls have different growth velocities and timings of the pubertal growth spurt. Thus, it is difficult to determine whether an individual child is experiencing catch-up growth relative to a child of a different sex and age. Therefore, the children's growth had to be compared with the healthy pattern of growth associated with modern populations, which in this case will be the WHO child and adolescent growth references developed in the mid 2000s (WHO, 2006). These provide an objective scale (Z-scores relative to modern standards) to determine whether boys and girls were experiencing catch-up growth at different ages and the magnitude of that catch-up growth.

Of course, for the children's catch-up growth to proxy their home environment before entering the institutions, the children and institutions must have met the preconditions for catch-up growth mentioned above: the children must have been well below modern standards in terms of growth at entry to the institution and the institutions had to provide substantially better conditions than what the children experienced in their home environment. Upon admission to the Marcella Street Home and Ashford School, the children had a mean height approximately two standard deviations below the mean height of modern children according to the WHO growth references and a mean weight one standard deviation below the mean weight of modern children. Thus, there was substantial room for the children to experience catch-up growth on these measures.

In addition, a close analysis of the institutions suggests that they did provide a better nutritional and disease environment than the children's home environment. The children had more than enough calories and protein in the schools even if their diet was a bit monotonous. They also were held to very strict hygiene requirements: the children washed their hands with soap and bathed regularly; they had modern flush toilets; they were given clean food and water; and they had access to extensive medical care provided by a medical officer and nursing staff. This likely led to lower mortality rates than in the surrounding area, though it is difficult to distinguish between children who entered the school with a fatal disease and those that contracted them *in situ*. Thus, the institutions did provide a significant positive intervention that could have sparked catch-up growth.

Having justified and explained the natural experiment at play, I then analyse the children's catch-up growth using multiple regression analysis. This multiple regression framework is necessary to control for some of the observed characteristics of the children that could influence their growth but more importantly to control for differences between the historical and modern growth curves. Children in the past experienced a delayed pubertal growth spurt relative to modern children, and this afffects the children's position relative to modern standards during adolescence. For instance, according to the WHO growth reference, girls begin their pubertal growth spurt around age 8 or 9 and their growth velocity reaches a peak at 11 before declining thereafter. However, girls in the Marcella Street Home reached their maximum growth velocity at around age 15. Thus, when the modern girls began their pubertal growth spurt, the historical girls would appear to be falling behind modern standards, and when the modern girls were experiencing slower growth after the pubertal growth spurt, the historical girls would appear to be experiencing rapid catch-up growth since they had started their pubertal growth spurt so much later.

Controlling for these differences between the modern and historical growth curve and for regression to the mean, there were not strong, significant differences in catch-up growth between boys and girls. Girls had an advantage over boys from ages 12 to 15, but this advantage was mostly driven by the differences between the historical and modern growth pattern described above. There were also no significant differences between boys and girls in their weight or BMI catch-up. This evidence, then, suggests that there were not strong gender disparities in health among working class children in late nineteenth-century America or early twentieth-century Britain.

Thus, although this paper mostly confirms the findings of recent research that there were not strong, unambiguous gender disparities in health in historical Britain or America, it tests for gender disparities using a new methodology, longitudinal catch-up growth, and it analyses the poorest echelons of the working class rather than the upper working-class and middle-class populations that have been studied in household budget surveys and the heights of school children in the past. In addition, I highlight some of the problems with interpreting gender disparities and improvements in health from cross-sectional height and weight data alone. Finally, the lack of a gender disparity in health has wider implications for the history of health in these countries. It suggests that there was not strong discrimination in the allocation of household resources in these countries, at least among children, by the late-nineteenth and early-twentieth centuries. Thus, the established health disparities between adult men and women likely arose in adulthood and were not the product of poorer female health in childhood and adolescence.

In the rest of the paper, I will first briefly describe the historical literature on gender discrimination in health and resource allocation outcomes. Second, I will describe the data sources, representativeness and potential selection bias. I will then provide an introduction to the WHO growth references and establish that these children met the two preconditions for catch-up growth. Finally, I will show that there were not significant differences in the level of catch-up growth between boys and girls.

2. Gender Differences in Health and Gender Discrimination 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 in three main ways: excess female mortality at various ages, discrimination in household allocation of resources measured in household budgets, and by differential influences of environmental factors on men and women's biological standard of living (height or BMI).[1] These indicators generally present a relatively 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 mixed evidence that women were not reaching equal outcomes to men in nineteenth and early twentieth century Britain and America.

Evidence on female mortality presents a mixed story of gender discrimination in Britain and America depending on the age range and specific locations studied. Woods and Shelton (1997) and McNay, Humphries and Klasen (2005) show that in the mid nineteenth century UK there was excess female mortality between the ages of 10 and 40 in Britain but by the 1890s there was only excess female mortality between the ages of 10 and 15. Surprisingly though, excess female mortality was more prevalent and applied to larger age groupings in designated "healthy districts" both at mid-century and in the 1890s. However, Harris (2008) has disputed some of these findings arguing that higher ratios of female to male deaths aged 0-14 in the mid-

[1] See Horrell and Oxley (2013) for a good summary.

nineteenth century relative to modern ratios were caused by the epidemiological environment. There has been less research on excess female mortality in the United States, but generally the literature finds that female and male mortality rates were very similar until the Civil War when excess male mortality became the norm (Pope, 1992; Haines, 2000; Vinovskis, 1972). Thus, overall the evidence on excess female mortality is very mixed in Britain and the United States.

Historians have also measured differences in the allocation of resources in the household directly. Horrell and Oxley (1999) and Logan (2010) used surveys conducted by the US Department of Labor in 1888-90 on working class households, but they did not find a clear and consistent pattern of gender bias in resource allocation in the household in either England or America. In England there were differences in allocation by sector but rather than confirming the simple hypothesis that children with the most labour market opportunities in the various sectors would be favoured with additional expenditure, Horrell and Oxley (1999) argued that three elements were important: 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. They 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. Logan (2010) similarly could not reject the efficient allocation of resources in the family in the United States; there was not bias against girls. However, he argues that 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" (p. 31). Thus, evidence on household resource allocation from late-nineteenth-century Britain and the US suggests that girls were not discriminated against, though the Department of Labor surveyed mainly the wealthier parts of the working class, those employed full time in factories or large establishments (Haines, 1981). Poor families may have faced more difficult decisions about allocating scarce resources.

A final method of measuring gender discrimination in the allocation of household resources is to look carefully at the differences in the anthropometric measures (heights and BMI) of boys and girls. Harris (1998) studied British children's growth in the early twentieth finding that when compared with British growth standards, girls' heights tended to be at higher percentiles of modern standards from ages 4-5 to 7-9 but that boys overtook girls by the age of 12-13. Similarly, when looking at the average height of children at a specific age over time, girls tended to be at a slightly higher percentile than boys across the first half of the twentieth century. He argues that the female advantage likely existed because girls are biologically more resistant to adverse conditions than boys and that these biological factors made it difficult to use height to measure gender differences in health. Studies of developing countries today have also found relatively small differences in child growth. In a study of 34 developing countries, Sommerfelt and Arnold (1998) found that there were "relatively small differences between boys and girls in terms of prevalence of stunting, underweight and wasting" despite the fact that some of the countries had clear male biases in other indicators. Dercon and Singh (2013) have also explored female bias in Ethiopia, Peru, India (Andhra Pradesh) and Vietnam, but generally found found pro-female bias in terms of nutritional status. These puzzling results where gender bias is not fully reflected in cross-sectional growth measures highlights the need for a new methodology of measuring relative deprivation.

To sum up then, there is mixed evidence of poor relative female health and gender discrimination in the allocation of household resources in nineteenth century Britain and America. These results, however, are complicated by the fact that most of the studies have focused on relatively affluent groups in society such as school children or full-time, employed workers. Thus, this study adds to the literature by developing a new methodology – studying boys and girls longitudinal growth – and by focussing on the working poor.

3. The Samples

3.1 The Marcella Street Home, 1889-1898

Before discussing the methods and results in detail, it is first necessary to provide some institutional context for the Marcella Street Home and the Ashford School and discuss the samples, representativeness and potential selection bias. The Marcella Street Home was founded in 1876 in Roxbury, a western suburb that had been annexed by Boston in 1868 (Board of Directors, 1878, pp. 27-8, 66-7). The Home was formed to house pauper and neglected boys who were resident 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 (Board of Directors, 1883, pp. 92-3). Boys and girls continued to be housed in separate departments throughout the life of the institution. The home was mixed race but only a small number of children in the school were black. 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. It is not exactly clear why the administrators began keeping these records in 1889; for instance, there is no change in the superintendent that year. However, the fact that the results of the anthropometric measures were never reported in the annual reports of the institution suggests that the figures are unlikely to have been deliberately skewed to depict the institution in a better light or influence policy in the institution or outside of it. The register includes the heights and/or weights of 475 children born between 1873 and 1898 with some children entering and leaving the institution multiple times. Age standardized 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 (*Marcella Street Home Register*, nd).

The children were drawn from all over Boston, including South Boston and Roxbury. The Board of Visitors (1895) 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.

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" ("Cruelty to Children," 1881). 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" ("A Public Meeting," 1882). 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. It also presents clear evidence that household resources were being syphoned off for the parents' benefit, not their children.

The question, then, is how would neglected children compare to Boston children in general. 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 (Billings, 1895, pp. 116-17), 65.9 per cent of children under five in Boston 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).[2] In the Marcella Street 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. While broadly similar, white children with native parents were significantly under-

[2] 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.

represented in the sample and white foreign-born children and black children were significantly over-represented in the sample. Thus, it appears that the poor and lower classes of immigrants and African Americans are over-represented among the sentenced children.

[Take in Table 1 here]

Another concern about using a register of neglected children is that the children might have had poorer health than poor children in Boston let alone the average child in Boston. This concern can be tested by comparing the Marcella Street Home children with other, more or less contemporaneous populations of children. In the early 1870s, the physiologist Henry Pickering Bowditch conducted a study on the growth of Boston school children, incorporating the heights and weights of 13,691 boys and 10,895 girls (Bowditch, 1879, pp. 35-6). He reported the mean height and later calculated percentiles for his sample. Bowditch's sample included both children whose parents were native and children whose parents were foreigners with a specific comparison of children of parents of native origin and Irish origin. The sample also included a fairly wide range of occupations, though children whose fathers were skilled labourers, which included many middle class professions, or belonged to the mercantile professions were likely over-represented relative to unskilled labourers (Table 2). However, Bowditch's sample does provide a good reference population with which to compare the neglected children in the Marcella Street Home.

[Take in Table 2 here]

Figures 1 and 2 graph the mean height of boys and girls upon admission and discharge from the Marcella Street Home with 95 per cent confidence intervals for each age against the median, 5th percentile and 95th percentile of height from the Bowditch sample. Surprisingly, the Marcella Street Home boys were at about the same height as the average schoolboy in Boston in the 1870s, and the girls were only slightly shorter than their middle class counterparts from the 1870s. Thus, the sentenced inmate children in the Marcella Street Home in the 1890s were not deprived relative to the Bowditch sample taken in the early 1870s. There are several possible explanations for this result. First, although the sentenced inmates had been neglected by their parents, they may have been more representative of the wider population of Boston children than the pauper inmates. However, a second and more likely possibility is that improving sanitation and hygiene and increasing income provided children with better health and nutrition shifting the distribution of children's heights upward between the 1870s and 1890s. Thus, although the sentenced inmates were about the same height as children in 1870s, they were still deprived relative to children in the 1890s.

[Take in Figure Nos. 1 and 2 here]

3.2 The Ashford School of the West London School District, 1908-1916

The West London School District was founded in 1868 to accommodate poor children from the London parishes of Fulham, Hammersmith, Paddington, St. George 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 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 (Monnington and Lampard, 1898, pp. 8-9; Board of Management, 1911, pp. 177-8). The board 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. Again, there is no indication why the institution began recording the children's anthropometric measures, but the administrators also never mentioned the measurements in the two thousand pages of minutes during this period, so it seems that the figures were probably not adulterated. Overall, 1,914 children born between 1892 and 1909 were collected from the register. Age standardized anthropometric measures 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 though because not all children were measured at discharge. The children's ages varied from 8 months 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 usually 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 lot of effort. 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 (Wood, 1991, pp. 98-100). They were representative of the working poor of West London generally.

It is also possible to compare the anthropometric measures of the children in the Ashford School with their contemporaries. Figures 3 and 4 compare the heights of boys and girls in the Ashford School with age cohorts of children measured in Barry, Wales, a leading coal port in Britain and in London. E. G. Habakkuk (1926, pp. 295-98) examined the medical cards of elementary school children born in Barry between 1902 and 1909, presenting the average heights of boys and girls at each age. His sample was quite substantial with 5,819 boys and 5,504 girls measured. Cameron (1979, p. 507) reports the average heights of 18,686 school children measured in London in 1905. A comparison between the Barry, London and Ashford School children suggests that the Ashford children were somewhat shorter than their Welsh and Londoner counterparts, though the gap was really quite small, especially when both are compared relative to modern standards. The small difference between the Ashford children and the other samples suggests that while the children in the

Ashford School were somewhat smaller, they were not completely destitute. Unfortunately, with the limited information available about the children in the Ashford School, this is the most sophisticated analysis of representativeness that can be completed.

[Take in Figure Nos. 3 and 4 here]

3.3 Sample Selection Bias: Was there a different selection process for girls and boys?

The last two sections have provided a sense of the samples and their representativeness, but one might also wonder whether the selection processes into each school would have affected boys and girls differently. If this were the case, then any inferences on health disparities might only be the product of selection biases rather than real differences. There is no reference to different admission selection policies for boys and girls in any of the extensive administrative records for the schools. However, the fact that there were more boys than girls in both of the schools raises questions about how children came to be admitted.

The gender imbalance reported above is exaggerated somewhat for the Marcella Street Home in Boston because of the large number of boys (123) and a few girls (6) who were sentenced for truancy in 1895 and 1896. These truants were slightly different than the rest of the population, which is why I included a dummy variable for them in the regressions. Once you remove the boys and girls sentenced for truancy, the gender balance in the home is slightly better with 194 boys and 152 girls (56.1 per cent male). For the Ashford in London, there were also more boys than girls: 833 boys and 642 girls (56.5 per cent male).

The simplest explanation for this is that both institutions had more capacity for boys than girls. Girls and boys were housed separately in both schools, and the boys' area was larger with more beds. This difference was mentioned in the sources and is corroborated by the relative stability of the total number of boys and girls living in each institution. The higher numbers of boys in the Marcella Street Home could have reflected its institutional history; it was founded as a home for boys with girls being added later when additional buildings were built to accommodate them. There were other public and private institutions where children could be sent in Boston in this period, but the only selection process that I have found that affected this would be truancy, which seemed to be a more common crime among boys, and mental disabilities, which removed boys and girls and placed them in another facility.

In London many poor law schools seemed to have had more boys than girls. In Monnington and Lampard's (1898) study of Poor Law Schools at the end of the nineteenth century, they list student numbers by sex for four schools and all of them had more boys than girls. Monnington and Lampard do not discuss the gender imbalance, which is puzzling. In addition, there were not enough girl only institutions to make up for the imbalance (in fact there were very few). For the most part each poor law union was responsible for their own children anyway, so it seems unlikely that they would be able to trade away the girls to other institutions. Thus, overall it appears that London Poor Law schools did not have an equal sex ratio: on average they were 57.5 per cent male (Monnington and Lampard, 1898, pp. 31, 68, 91, 94, 96, 108).

Some of the children under the care of London Poor Law Unions were not put into Poor Law Schools. In c. 1897 there were approximately 14,400 children under the care of the London Poor Law Unions: 11,500 were being cared for in poor law schools like the Ashford School; 1,100 were boarded out; and 1,800 were in workhouses or infirmaries (500 of this 1,800 were under the age of 2). Thus, it is possible that girls were over-represented among children who were boarded out or living in the workhouse. However, it seems unlikely that this was the case. If we assume that the sex ratio among children cared for by Poor Law Unions was equal and that the gender imbalance in the schools had to be made up among children boarded out and in workhouses, this would suggest that 80 per cent of children boarded out or in workhouses were female. Given the fact that neither Monnington and Lampard nor a number of other scholars mention gender imbalance in the poor law system, it seems unlikely that it could have been so skewed.

Thus, if the girls were not being diverted into different institutions in Boston and London, why did boys outnumber girls? There are four possible explanations for this imbalance, which I will deal with in turn. Although some of these might lead to minor selection, they would not lead to selection based on health by gender.

[Take in Figure Nos. 5 and 6 here]

One possible explanation is that girls were valued for their domestic work in the home and were therefore not institutionalized as frequently by parents, workhouses and courts. If this were the case, we might expect to see different age distributions of children at admission and discharge from the home and specifically fewer girls being admitted to the home at older ages and more girls being discharged at earlier ages than their male counterparts. Figures 5 and 6 present the distributions of age at admission and discharge for boys and girls in both schools. It does appear that older girls were less likely to be admitted to the Marcella Street Home than boys of the same age and older girls were slightly more likely to be discharged, but this difference was relatively small. In the Ashford School, the admission and discharge age distributions by sex were nearly identical and do not support this argument.

Another way of testing the hypothesis that girls were kept at home for their domestic skills is to look at the difference between children entering with other siblings and children entering on their own. We would expect more gender balance among children entering with their families in the Marcella Street Home since the entire family was sentenced together. However, among the 70.8 per cent of non-truant children who entered the Marcella Street Home with a sibling, boys still substantially outnumbered girls (130 boys and 105 girls). This is puzzling because we would expect the gender ratio to be fairly equal within families barring substantial excess female or male mortality. This pattern is also present in the Ashford School for children arriving with and without their siblings.

Looking at the ages of children who arrived with and without their families (Table 3), there were relatively few differences between boys and girls in the Ashford School. However, in the Marcella Street Home, there were differences between children entering with their families and children entering alone. Even when excluding truants, at median, girls entering with their siblings were 1.17 years older than boys entering with siblings, but boys entering alone were 3.04 years older at median than girls entering alone. These patterns were similar for discharge age although the ages converged somewhat. This suggests that the pattern of keeping girls at home at older ages when they could contribute to the upkeep of the home was not present among children entering with families since girls were older than boys in this group. However, for children entering without siblings, it may have been the case that older girls were kept at home. In any case, even if this selection were in place, and the evidence is dubious, this would not have led to the systematic selection of unhealthy girls or boys into the institutions. Age was more important than health to a girl's ability to help around the house.

[Take in Table 3 here]

Another possible explanation for the higher numbers of boys than girls in the institutions has to do with the sex ratio of the population from which they were drawn. Male births tend to outnumber female births at a ratio of 1.06 to 1, so unless this initial advantage was compensated by higher infant mortality among boys, we would expect there to be slightly more boys than girls. This starting imbalance could also have been higher among the working poor since stress during conception is linked with higher secondary sex ratios (more males at birth). If there were also excess female mortality in childhood, this would compound the early male advantage and lead to higher sex ratios by the time the children entered the institutions. This is a nice argument, but it is most likely wrong. Although there was excess female mortality in England in many areas, London had mostly excess male mortality in the second half of the nineteenth century (Woods and Shelton, 1997, p. 137). Likewise there were not clear patterns of excess female mortality in nineteenth century Massachusetts (Vinovskis, 1972, pp. 207, 211). Thus, this cannot explain the gender imbalance.

The gender imbalance could also have been created if there was a societal preference for adopting or placing out girls. If this were the case, we would expect girls to have a shorter length of stay in the school than boys. Thus, admissions levels would be relatively equal, but the girls would just pass through the institutions more quickly as they were placed out. Admissions levels in both schools were never equal across the genders. There were always more male admissions, and the stock and flow were fairly similar. In the Ashford School from 1908-1916, boys made up 56.5 per cent of admissions, 56.2 per cent of discharges and 58.5 per cent of the stock taken as the average percentage males in the institution in January of each year. In the Marcella Street Home, 57.1 per cent of admissions of non-truant, sentenced inmates were boys and 57.3 per cent of discharges were boys. Stock figures for the Marcella Street Home are harder to determine because the stock figures reported in the annual reports include the truants and the surviving register does not include the pauper boys and girls who made up the majority of the school. Figure 7 shows the length of stay in each institution by gender. It seems that non-truant girls had slightly shorter stays in the Home than their male counterparts, but the distributions are clearly very similar and do not strongly support this hypothesis. Thus, the gender imbalance was not a product of moving girls more quickly through the home than boys.

[Take in Figure 7 here]

Information was available for the Marcella Street Home about where the children went after they were discharged from the home (Table 4). In relative terms, girls were more likely to be placed out, but boys still out-numbered them in absolute terms. In addition, the Marcella Street Home was shut down in 1898 because all of the children could be placed out, so it seems that placing out male children was not an impossible feat. Boys were more likely to be returned to their families than girls, which might have counteracted any female bias in adoptions. Thus, it seems unlikely that differences in the desirability of adopting girls versus boys could have resulted in the gender imbalance in the home.

[Take in Table 4 here]

Finally, if different children were being selected because of their earlier health status, we might expect to find a relationship between the child's initial anthropometric measurements and the length of time they were kept in the institution (for the first time). These correlations are reported in table 5. Nearly all of the correlations were extremely low even if they are occasionally significant. The only exception is the correlation between weight-for-age Z-score and the length of stay in the Marcella Street Home. At -0.324 and -0.181 for girls and boys respectively, it may indicate that children who were underweight at entry were held in the home for longer and that this may have favoured girls somewhat, but this was not a major factor in determining the length of time children spent in the home.

In the end, it is difficult to know why there were more boys in these institutions than girls.[3] However, the fact that there were more boys than girls does not necessarily mean that there was a different selection mechanism for boys and girls or that the institutions selected children based on their health. Thus, I will proceed based on the assumption that sample selection bias is not highly problematic for the analysis.

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[3] Interestingly enough, there is still a gender imbalance for children under state care in London: 56 per cent of children in care were boys in March 2013 (https://www.gov.uk/government/publications/children-looked-after-in-england-including-adoption). In Massachusetts, 53 per cent of children in foster care in 2012 were boys (Kids Count Data Center: http://datacenter.kidscount.org/data/tables/6245-children-in-foster-care-by-gender?loc=23&loct=2#detailed/2/23/false/868,867,133,38,35/14,15,112/12990,12991).

[Take in Table 5 here]

4. Growth References, Growth Curves and Measuring Catch-up Growth

4.1 The 2006/7 World Health Organization's (WHO) Growth References

In order to compare the growth of children across countries and time periods, 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. For more information about these modern references and how they compare with other references used by historians in the past, please see the technical note available on my website (Schneider, 2015).

Exploring the WHO growth reference further, Figure 8 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 intervals over time, i.e. the growth between one-year cohorts in cross-section (Figure 9). From these figures it is clear that girls experience a pubertal growth spurt 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. These growth spurts tend to be delayed in malnourished populations. It is also important to note that the growth intervals in Figure 9 are measured using cross-sectional rather than longitudinal measurements of children's heights. If individual children had been measured longitudinally, there would have been a more pronounced acceleration of growth during the pubertal growth spurt. Thus, the more gradual growth spurt for girls in the cross-sectional height interval graphs reflects higher variance in the timing of the pubertal growth spurt rather than a slower, less distinct growth spurt than men (Eveleth and Tanner, 1990, p. 10; Cole, 2006, p. s242).

[Take in Figure Nos. 8 and 9 here]

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 10, 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.

[Take in Figure No. 10 here]

4.2 Catch-up Growth through the Life of Daniel O'Brien

Traditionally, when anthropometric historians have measured children's growth in the past they have either studied pooled cross-sectional data of children's heights or they have analysed the aggregate statistics published by experts. Steckel (1986) pioneered these methodologies to study slave children, but they were quickly applied in Britain as well. Floud, Wachter and Gregory (1990, pp. 163-82) studied boys enlisted in the Marine Society in London and in the elite military academy of Sandhurst from the mid-eighteenth to mid-nineteenth centuries. Likewise, Harris (1995, pp. 84-9) used the aggregate statistics on children's stature recorded for certain ages in the school medical officers' report books around Britain to study children's health in the twentieth century as was already mentioned above. In these initial studies and in follow ups, the authors tracked changes in stature at particular ages over time and compared the children's height to modern standards for growth. These studies have provided some interesting findings about the secular trends in stature over time and the multi-causal factors influencing growth, but they have been limited by the cross-sectional nature of the data. This study is unique, then, because it makes use of longitudinal measurements of children's heights and weights, which allows us to make better inferences about growth.

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. There are three types of catch-up growth. Type A 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. For type A catch-up the degree of catch-up growth depends on the length of the intervention and on the relative deprivation of the child before the intervention (Adair, 1999, pp. 1140-1; Tanner, 1981; Eveleth and Tanner, 1990, pp. 192-3; Gluckman and Hanson, 2006, p. 9; Prentice *et al.*, 2013, p. 915). Type B catch-up growth occurs when growth continues at normal rates, but the growth period is extended to by much longer than that of modern populations. Type C catch-up growth is a combination of type A and type B (Boersma and Wit, 1997, pp. 647-8). This paper will only measure type A catch-up growth because the children are not observed at adulthood, so there was no way of measuring their type B catch-up growth.

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 11, 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 the 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 12). 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.

[Take in Figure Nos. 11 and 12 here]

5. Preconditions for Catch-up Growth

Having explained the samples and methodology, I must now show that the children and the institutions are a good fit for the natural experiment employed in the paper. In order for the children's catch-up growth to represent the conditions the children were experiencing before entering the institutions, the children must experience two key preconditions. First, the children had to be substantially below modern standards before the catch-up period began. Second, there had to be a positive intervention that improved nutrition and decreased the disease load allowing catch-up growth to occur. This section proves that these preconditions were met.

5.1 Relative Deprivation of Children

The children's growth in the Marcella Street Home and the Ashford School was different than modern populations in two key respects: the absolute level of height or weight at any given age was lower than modern children and the children also seemed to follow a different growth curve both in terms of BMI and height.

Figure 13 shows the raw distributions of boys and girls heights at admission to both institutions as Z-scores of modern standards (table 6 presents the descriptives). 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 the bottom one 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 Marcella Street Home is not driven by the boys sentenced for truancy who had a different socioeconomic background than the other children because the distributions remain different if these children are removed.

[Take in Table 6 here]

[Take in Figure No. 13 here]

The children were also behind modern standards in terms of weight-for-age, which could only be calculated for children under 10 years old because the reference becomes less useful after that point. Figure 14 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 might have been expected to make a catch-up in weight-for-age scores.

[Take in Figure No. 14 here]

Finally, in terms of BMI-for-age, the children in both schools were mostly in the normal BMI range between two standard deviations below the mean and one standard deviation above the mean (Figure 15). 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. We would therefore not expect to find catch-up in BMI.

[Take in Figure No. 15 here]

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) as a measure is 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 the children had the high body fat percentages that we now associate with overweight and obese individuals. Second, BMI is a 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 (see the previous section); mean BMI-for-age decreases to the adiposity rebound around age five in modern populations and then begins increasing thereafter. 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 sign that they were in good health. Thus, the interpretation of BMI levels and changes in BMI for children is not as clear or intuitive as similar levels and changes in height and weight.

Finally, the interpretation of BMI-for-age is complicated because it appears that children in history may have had a different BMI growth curve than children growing up in the late twentieth century. The BMI growth curves for children in the Ashford School and Marcella Street Home compare well with the BMI growth curves collected by some of the first anthropometricians of the late nineteenth century, Henry Pickering Bowditch (1891, pp. 482, 485, 489, 491) and the anthropometric committee in Britain (Farr *et al.*, 1879, p. 180). The mean BMI of historical children tended to be above the mean BMI of modern standards until the age of ten or eleven when it permanently fell below modern standards (Figures 16-17). The curves thus tended to be quite flat with the only increases in BMI taking place after the age of 15. In addition, the adiposity rebound, the nadir of the mean BMI growth curve, took place later in historical populations at around age seven or eight. The differences between the historical and modern BMI growth curve are particularly problematic because they suggest that there might be differences in the measured BMI growth in the short run and the long run. In the short run, children could put on a substantial amount of weight in a relatively short period of time in anticipation of gains in height, increasing their BMI. But if children are only observed in the long-run, as is often the case in this chapter, then their BMI growth relative to modern standards would likely be negative.

Children in the past may have had higher BMI values than children in the present for a number of reasons. First, good heating in a home was costly, so children and adults likely needed a higher fat content in their body to help protect them from the cold. In addition, without antibiotics and modern medicinal practices, when children became ill, they were often sick for weeks at a time. The illness would sap the child's resources in two ways. First, many chronic digestive diseases such as diarrhoea prevent the body from absorbing the nutrients consumed, and second, the immune system requires enormous amounts of energy to fight off a disease, so the child would have to expend most of its energy on fighting the disease rather than growing or developing (Floud *et al.*, 2011, pp. 11-12). Finally, Waaler's (1984) 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 today's acceptable range (Floud *et al.*, 2011, pp. 57-72). 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 than children in modern populations. Thus, despite their normal BMI figures, we would expect children in these institutions to experience catch-up growth.

[Take in Figure Nos. 16 and 17 here]

5.2 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 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" (Institutions Commissioner, 1898, p. 14-15). The new superintendent, Michael J. Dwyer, who took over abruptly from the previous superintendent under mysterious circumstances in October 1896, noted "that the diet of the inmates, while apparently sufficient in quantity, was lacking in quality, variety and service" (Institutions Commissioner, 1898, p. 115). 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 (Institutions Commissioner, 1898, pp. 14-15, 116; Children's Institutions Department, 1898, pp. 20-1).

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. This November 1896 diet was intermediary because it included molasses, which was not a part of the older diet and was one of the first additions to the diet, but did not include the fruit and vegetables, which were added in the final diet. However, the November 1896 diet can be compared with the recommended diet put forth by the expert committee (Table 7). 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[4] 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, 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. The committee acknowledged that their recommendations of food for children were high. In fact, they were substantially higher that the energy requirements calculated by Atwater and cited in the report for children aged 7-10: 2,025 calories, 75 grams of protein, 60-75 grams of fat, and 249-283 grams of carbohydrates (Institutions Commissioner, 1898,

[4] See Schneider (2013a, pp. 343-5).

pp. 184-96). They justified the high food expenditure by arguing that the children had "probably been under-nourished, and must be brought to a good *physical* condition before good *moral* results may be expected [sic]" (Institutions Commissioner, p. 188). They also argued that Carroll D. Wright had estimated that children 8 to 10 needed 75 per cent as much food as an adult, and that the children's diet corresponded to three-quarters of the requirements of a moderately active man. 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 (Children's Institutions Department, 1898, p. 20; Institutions Commissioner, 1898, p. 116).[5] Thus, it is clear that the committee was actively trying to promote healthy diets for children in these institutions.

[Take in Table 7 here]

However, the 2,459 calorie diet, which was in place before the dietary changes, 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 (Schneider, 2013b, p. 101; FAO, 2004, pp. 26-7). 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 95 grams of protein in the diet would have also

[5] 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 (2013a, pp. 341-4).

provided plenty of protein considering that Allen's respectability basket provides 112 grams of protein for an adult male (Allen 2009, pp. 36-7; Schneider, 2013b, p. 102). It should also be noted that there is no indication in the annual reports from the home that girls were fed less than boys. Sometimes the girls received slightly different foods, but there is no reason to believe that there were gender differences in food that would affect the children's growth. Clearly, the children received a better diet in the Home than before entering the institution.

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 (1895, p. 44) 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.

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 (Public Institutions Department, 1893, pp. 90-1).

It is also possible to compare mortality rates for children in the Marcella Street Home with children in Boston as a whole. This, however, is not a simple task. Although child deaths are reported in the annual reports for the entire period that the Home was open, monthly totals of children are needed in order to calculate the exposure risk that children faced in the home. The age breakdown of the children is also not reported, so I will compare the calculated rates with those of children aged 5-

10 and 10-15 in Boston. However, it is possible to calculate the death rates for each year and compare these with similar information on deaths in Boston. Table 8 shows the mortality rate of children in the Marcella Street Home and the associated rates in Boston in the same years. The rates in the Marcella Street Home fluctuate more than the rates in Boston, but this is likely just an artefact of the small number of deaths in the Home. The average mortality rate for children in the home across the period (8.2 deaths per thousand) is slightly lower than the average mortality rate of children aged 5-10 in Boston (8.9 deaths per thousand) but higher than the average mortality rate of children aged 10-15 (3.9 deaths per thousand). Since the average age of children to the Home was 9.04 at entry and 10.34 at discharge, the death rate was likely higher in the Home than in the population of Boston as a whole.

However, there are two important points to consider before judging the home too harshly. First, the children in the Marcella Street Home were of lower socio-economic status than the average child in Boston. Although the data do not exist, it is fairly safe to assume that working class children suffered from higher mortality rates than their middle and upper class counterparts. Therefore, the mortality rates in the Marcella Street Home might be better than the mortality rates for working class children in Boston. Second, Superintendent Heath mentioned in the annual reports that some of the twenty deaths that occurred between 1884 and 1890 were caused by diseases the children already had before entering the institution (Board of Directors for Public Institutions, 1886a, p. 171; Department of Public Institutions, 1895, p. 128). Thus, if it were possible to control for fatalities from diseases contracted at the Marcella Street Home, the mortality rate would be substantially lower. Thus, it seems plausible to assume that conditions were much more sanitary in the Home than in the houses and neighbourhoods where the children lived before entering the Home.

[Take in Table 8 here]

In the mid 1890s the opinion of the Commissioners of Public Institutions, who oversaw the Home, began to change. The key problems with the institution were the dilapidated buildings and its proximity to the city stables and swill shops. This is first mentioned in the Commissioner's report for 1894, but was quickly followed by assurances that "this institution is in most excellent condition" (Public Institutions Department, 1895, p. 21). In subsequent years, the rhetoric became more assertive with Superintendent Dwyer (in post 1896-1898) writing at the beginning of 1897 that "the odors permeating our entire institution from this nuisance are at times nauseating" (Public Institutions Department, 1897, p. 120). The swill plant was finally closed later that year, only one year before the institution itself closed (Children's Institutions Department, 1898, p. 15).

The increasingly harsh rhetoric was also noted in regard to sanitation improvements, particularly in the boys section of the home. White oversaw the installation of new modern flush-toilets in the hospital and lower floors in the second half of 1895, but this did not prevent his successor, Dwyer, from criticizing the plumbing further and building additional toilets and new showers for the children in 1897 (Public Institutions Department, 1896, p. 139; Children's Institutions Department, 1898, p. 15). Dwyer also mentioned that the boys were less clean than the girls, and the secretary of the medical staff reported that "over one hundred and fifty boys use accommodations sufficient for not more than a tenth of that number" (Public Institutions Department, 1897, pp. 155, 127). This might suggest that the boys were experiencing worse conditions in the home than their female counterparts.

However, it is impossible to verify whether poor hygiene and overcrowding created a higher disease load for boys because disease incidence was not reported separately by sex in the medical officers' reports.

Between the change in diet, the removal of the swill plant, and the construction of new toilet systems and showers, it may seem that the Home improved drastically after Dwyer took over in 1896. These improvements were certainly beneficial, but Dwyer's condemnation of the old system has to be tempered against a changing political climate after 1895. At this point and into 1896, Josiah Quincy, the grandson and great-grandson of former mayors, was elected mayor of Boston. Quincy believed that the city government could do more to serve the interests of its poorer inhabitants and took a greater interest in the Home and all of the public institutions more generally, visiting the Marcella Street Home personally at least twice ("Comr. Marshall Active," 1896; "Dr. White Not Removed," 1896; Mayor Josiah Quincy III, n.d.). Mayor Quincy started reforming the institutions quite quickly. The mayor was likely responsible for removing Superintendent White from his position in October 1896 and replacing him with Dwyer. The mayor's office denied that White had been removed in a statement two weeks before Dwyer took over the Home, but it appears that this was merely the mayor's response to a press leak of his plans ("Dr. White Not Removed," 1896). The mayor also promoted legislation that eventually changed the administrative structure of the public institutions department, establishing separate departments to manage institutions for children, the insane, paupers, and criminals. This was meant to rationalize the administrative structure, but it also gave Quincy the power to appoint unpaid trustees to oversee the new departments ("In Three Groups," 1897). Thus, it is not surprising that the tone of the reports shifted to match Quincy's political agenda.

The descriptions of the Marcella Street Home morph from the Commissioners of Public Institutions describing the home as in excellent condition in early 1895 to the following hyperbolic description by the Trustees for Children in early 1898 (Children's Institutions Department, 1898, p. 4):

> In the heart of our city, surrounded by a wooden fence 10 feet high, with barbed wire on its top, stands a large building which . . . became the Marcella-street Home, the institution to which Boston sends the children whose parents are unable to care for them, and the children of those whose cruelty and neglect have caused the courts to send them there. . . . On one side of this high fence are the city stables, breeding rats, on another a dump, where until last year, city swill was deposited. In this prison, under lock and key, these innocent children, deprived of their homes through no fault of their own, are expected to grow up into self-respecting citizens.

Therefore, it is possible that Dwyer and the trustees sharpened their rhetoric on the Home because they favoured a system where neglected and poor children were placed with foster families rather than being raised in an institution. Thus, it seems that placing the children out with foster families became the medium term goal for Dwyer and the mayor because the Marcella Street Home was closed in 1898 when all of the children could be housed with foster families. However, the trustees' disgust for the Home was not merely limited to the mayor's political allies. In 1899 a member of the common council of Boston and a political opponent of Mayor Quincy made the following argument when one of his colleagues suggested that the Marcella Street Home be renovated to accommodate truant boys that were being held at another institution on Rainsford Island at the time ("Meeting of the Boston Common Council," 1899).

> The Marcella Street Home is not fit to be used for a stable for bum contractors of the city of Boston let alone for any human being. The institution at Marcella Street Home is a disease-breathing spot. There is not sufficient light in the rooms for the children to see for an hour a day. I say that whatever bad acts the Trustees for Children have committed—and they have committed many of them—one good act which they have done was to close the Marcella Street Home.

Thus, the rosier depictions of the Home in the early 1890s probably understated some of the problems with the location and its administration, but at the same time Dwyer and the trustees' horrific descriptions of the Home must be counterbalanced with knowledge of their political goals. Dwyer and the commissioners and trustees highlighted real problems and carried out substantial improvements after 1896, but the evidence presented later in the chapter suggests that the institution was not as bad as some of the descriptions would have us believe. Therefore, it seems plausible that the Marcella Street Home provided a better sanitary environment and better food in larger quantities than the children would have received in their own homes. In other words, the institution provided an opportunity for catch-up growth.

5.3 A Positive Health Intervention: The Ashford School, 1908-16

Conditions in the Ashford School were also substantially better for pauper children than the conditions they experienced before entering the institution. The diet in the Ashford School was somewhat more varied than the Marcella Street Home, but it was still fairly monotonous (see tables 9 and 10). The children had the same thing for breakfast every day: cocoa (made with milk), bread and margarine. They had a light lunch of sultana bread followed by a major meal at dinner. 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 for 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 mains dishes such as baked mutton, baked beef, meat pie, raisin 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 milk) and treacle and cheese two to three times per week (*Dietary Tables*, 1909). The children's diet seems to be lacking, however, in fresh fruit, which is corroborated by the fact that gifts of oranges for the children were always recorded in the board of management signed minutes (Board of Management, 1908, p. 42; Board of Management, 1910, p. 63, Board of Management, 1911, p. 36; Board of Management, 1913, p. 81; Board of Management, 1914, p. 55; Board of Management, 1915, pp. 18, 72).

[Take in Table 9 here]

It is more difficult to attempt 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 (*Dietary Tables*, 1909). 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. Tables 9 and 10 also display the number of calories and grams of protein per day that children received in the two age categories. There was considerable variation across the week in each category. Young children were provided with between 1,641 and 1,930 kcal per day with an average of 1,708 kcal per day. The older children received more calories ranging from 1,896 kcal per day to 2,874 kcal per day with a mean of 2,404 kcal per day.[6] These ranges were probably wide in part because of the imprecise nature of the calorie calculations, but the children did appear to be given more food on Wednesdays and Saturdays. With regard to grams of protein in the diet, the

[6] 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 falls to 2,216 kcal/day.

younger children received 59 grams of protein on average per day, while the older children received 70 gram 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 (Schneider, 2013b, p. 101; FAO, 2004; pp. 26-7). 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 the fifteen-year-olds in the school. 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.

[Take in Table 10 here]

The superintendent and board of management were also acutely interested in maintaining the quality of the food that they provided for the children. They were constantly sending back meat without labels and other meat that did not meet their expectations. This was especially a problem at the beginning of the period studied here in 1907-8 and as World War I began to affect the meat supply in 1915 (Board of Management, 1907, p. 138; Board of Management, 1908, p. 31; Board of Management, 1914, p. 64; Board of Management, 1915, pp. 55, 91). They also had problems throughout the period with procuring enough milk. Early in the period, the school owned a dairy herd that provided its milk, but the cows did not always produce sufficient milk (Board of Management, 1907, p. 118; Board of Management, 1908, pp. 38, 153, 158). This problem reached a peak in September 1908 when the superintendent reported that during the last ten weeks “the weekly supply [of milk] fell from 2,864 pints to 1,740 pints” or a decline of 40 per cent (Board of Management, 1908, p. 153). This prompted the Board of Management to sell the herd and procure the milk through private contractors. As a part of the review of this policy change the medical officer suggested that all milk be boiled and that it be periodically tested for contamination (Board of Management, 1908, p. 204). There is evidence that these recommendations were followed throughout the period studied with the board taking a very strict stance; they found the milk to be deficient in fat in August 1916 and questioned the contractor about it (Board of Management, 1909, p. 151; Board of Management, 1910, p. 62; Board of Management, 1914, p. 80; Board of Management, 1916, p. 70). The superintendent and board also had problems with the quality of flour, margarine, raisins, and cocoa delivered various times (Board of Management, 1907, p. 68; Board of Management, 1909, pp. 155, 160; Board of Management, 1910, pp. 149, 159; Board of Management, 1911, pp. 20-1, 29-30; Board of Management, 1913, p. 148; Board of Management, 1914, p. 41). All of these anecdotes highlight how vigilant the school was in providing the children the best quality of food that they could afford.

Sanitary conditions in the West London School District 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 (Board of Management, 1908, pp. 78-85). Earth closets were an advancement upon the privies of the past because the excreta was kept in a closed container that was regularly cleaned out rather than letting the excreta soak into the soil and enter the water supply. They were called earth closets because dirt was added periodically to the mixture to help decompose the waste. Earth closets were initially seen as superior to water closets because water closets often emptied into caverns or poorly constructed septic tanks, thus ensuring that the excreta thoroughly soaked into the soil (Wright, 2000, pp. 208-10). However, it is not hard to imagine how water closets (primitive flush toilets) connected to a functioning sewage system would be a great improvement for sanitation, especially around small children. Removing the waste immediately from the lavatory eliminated the need for emptying the earth closets, reducing the amount of contamination in the lavatory and allowing the saved labour hours to be used to keep the lavatories cleaner. Major sewage improvements were undertaken at the Ashford School 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 (Board of Management, 1909, p. 126; Board of Management, 1911, p. 43; Board of Management, 1908, pp. 78-85). The board of managers and medical officer were displeased with the works at first because the pump that moved the sewage through the system was blocked several times in February, March and April of 1910. The medical officer made the following report in April 1910 (Board of Management, 1910, p. 62):

> During the past few months the School has not been in satisfactory sanitary condition, and remains so. Some of the children have headaches, and are feverish; some sick and state they fell ill; others have sore throats, and some with pneumonia and pleurisy. All the milk is boiled. The water has been analysed, and found to be fit for drinking. The food appears to be good. By the process of elimination it would appear that the drainage system is still at fault and probably the cause of the condition.

The next month, the medical officer even grumpily reported that "the ground near the Boys' Playgound has been recently saturated with sewage" (Board of Management, 1910, p. 75). However, after a temporary pump was installed and the system was modified, the insanitary conditions seemed to subside (Board of Management, 1911, p. 43). There was a later report in 1912, which indicated that the boys needed training on how to use the new facilities properly. The boys were all using one toilet, which quickly became blocked, rather than spreading the load across a larger number of toilets in the lavatory (Board of Management, 1912, pp. 69-71). However, by September 1915 after the final adjustments had been put in place, the system was reported to be working “in a most satisfactory manner” (Board of Management, 1915, p. 158). In addition, aside from the brief period at the beginning of 1910 described above, there were no references to illness being the result 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 the drinking water was regularly tested for signs of impurity (Monnington and Lampard, 1898, p. 8; Board of Management, 1907, pp. 47, 56-7, 141; Board of Management, 1910, p. 63; Board of Management, 1911, p. 2; Board of Management, 1913, p. 101; Board of Management, 1914, pp. 14, 32). The water tanks were also regularly cleaned and improved over the years (Board of Management, 1907, pp. 56-7; Board of Management, 1910, pp. 18, 21-2; Board of Management, 1914, p. 114; Board of Management, 1915, pp. 40, 97, 193; Board of Management, 1916, p. 51). 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 (Board of Management, 1909, pp. 24, 42, 49). 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 (Board of Management, 1908, p. 169; Board of Management, 1910, p. 192).

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 (Board of Management, 1912, p. 216). There were several motions over the years to replace the tub baths, in use at the beginning of the period, with spray baths akin to showers. Spray baths were more sanitary because it meant that children did not have to share bath water. However, it is not entirely clear that this transition ever took place because the building works for the new spray baths were delayed again and again (Board of Management, 1907, pp. 6, 19, 85, 100, 115; Board of Management, 1909, pp. 110-11; Board of Management, 1913, pp. 166-67; Board of Management, 1914, pp. 7-8, 73, 136). There are some references though to limited spray baths being in use by 1910 (Board of Management, 1910, p. 84; Board of Management, 1914, pp. 7-8). The children also washed their hands with soap frequently in primitive sinks, again avoiding contamination through sharing water (Board of Management, 1907, p. 100; Board of Management, 1909; p. 97; Board of Management, 1910, p. 81). Monnington and Lampard (1898, p. 10) mentioned that the children had clean towels three times a week, but this cannot be corroborated for the later period in the minutes. The older children were also provided with a toothbrush and brushing powder to brush their teeth regularly (Board of Management, 1911, p. 212; Monnington and Lampard, 1898, p. 10). 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 staff attempted to prevent the spread of illness within the school and introduction of new illnesses from outside by quickly quarantining sick children and enforcing strict rules about visitation and admission. Children with different illnesses were kept in separate wards in the infirmary, and they were not allowed to re-enter the general student population until they were fully recovered. In January 1909, the superintendent even prevented the children from taking afternoon walks around the school's extensive grounds because there was an outbreak of Measles in the area (Board of Management, 1909, p. 12). Later in 1914, the medical officer advised that children confirmed to have fevers such as scarlet fever and diphtheria should be removed from the school and sent to the Metropolitan Asylums Board's Hospital (Board of Management, 1914, p. 211). The school also owned a large steam disinfector, which was used to disinfect clothing and bedding (Board of Management, 1907, p. 32).

In addition, there was a set of policies that prevented disease from entering the school. Each child entering the school was held in the lodge for a couple of weeks to ensure that they were not carrying any diseases (Board of Management, 1916, p. 63). In February 1907, the children housed at the Lodge were kept in quarantine for an additional fortnight because several children were returned from a convalescent home where there had been a scarlet fever outbreak (Board of Management, 1907, p. 27). Likewise, when epidemic diseases were ravaging the school or London, the school temporarily stopped admitting children to protect the existing student population; for instance, admissions were suspended in June 1911 after four children became ill with diphtheria (Board of Management, 1911, p. 87). The medical officer and superintendent also limited visitation rights during periods of epidemic hazard in London, though the board was generally reluctant to keep parents and relatives from visiting their children (Board of Management, 1907, p. 151; Board of Management, 1913, p. 221). However, between July 1914 and September 1915, children under 16 were not allowed to visit the home at all because of fears of scarlet fever in London, though the board eventually removed the ban believing the medical officer's recommendation that it be adopted permanently overly cautious (Board of Management, 1914, pp. 134, 170, 182, 211, 221; Board of Management, 1915, pp. 5, 40, 71, 97, 147, 162). These procedures generally kept the incidence of infectious diseases in the school to a minimum; most of the child deaths described in the minutes were from heart disease or other chronic illnesses rather than infectious diseases.

The children's health and growth was also 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 (Board of Management, 1907, 15; Board of Management, 1908, 2; Board of Management, 1909, p. 26; Board of Management, 1910; pp. 5-6; Board of Management, 1911, p. 3; Board of Management, 1916, p. 103). 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" (Board of Management, 1908, p. 2). 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[7] in February compared to one case that year (Board of Management, 1908, p. 26).

[Take in Table 11 here]

[7] Chilblains is "an inflammatory swelling produced by exposure to cold", *OED Online*.

Physical activity and work also affected the children's nutritional status because they would need more calories if they were working harder. The Ashford School's first mission was to educate the children resident there. Thus, most of the children in the home were in school lessons for a large part of the day. However, a number of older boys and girls were given full or partial exemptions from the classes having either passed out of them or reached an age where more practical skills were deemed necessary. The number of boys and girls at work, then, was somewhat independent from the actual labour required day to day in the school (Board of Management, 1908, p. 33; Board of Management, 1910, p. 20). Table 11 presents the number of boys and girls working in various tasks in May 1907 and the amount of time they worked per day. Girls tended to work much longer hours than boys, but a larger percentage of the boys worked: 107 of the 352 boys over the age of six in May 1907 worked (30.4 per cent) whereas only 31 of the 268 girls over the age of six worked (11.6 per cent). However, there were 42 other girls only given a partial exemption from school who attended lessons in "Housewifery" fives times per week (Board of Management, 1907, pp. 58, 62). There was some concern that the working hours for girls and for boys working in the Bakery were too long, but the girls' hours were never reduced. The hours worked by boys in the bakery, however, were reduced to six hours in April 1910 (Board of Management, 1907, pp. 83, 111, 171; Board of Management, 1910, pp. 20, 69). It is difficult to precisely identify how this work would have affected the children. The girls were likely working harder because they worked longer hours and had to carry heavy laundry around and clean, but the boys were also engaged in hard activity such as working on the farm and more of them worked. In addition, the boys often played football, increasing their energy expenditure. On balance, then, it does not appear that either the boys or girls worked significantly harder than the other. In any case, this work effort would have only mattered if the children were not receiving enough food to cover their energy costs, but given the very generous diet, this would seem to be unlikely.

The punishment regime in the school could have also influenced the children's health if they were forced to carry out hard labour or if corporal punishment was overused. However, neither of these seem to have been the case. An extensive list of punishments is described in the board of management minutes in February 1912. Punishments varied by sex, but the only punishment that could possibly qualify as hard labour was one of hour of scrubbing, which was used as punishment for boys only (Board of Management, 1912, p. 43). Corporal punishment was strictly forbidden for girls. It did take place from time to time, but whenever the board of management became aware that girls were struck or caned, they immediately forced the resignation of the staff member involved: the headmistress, Miss Mark, was dismissed for admitting to caning the girls in December 1910 and an assistant chargemaster was fired in February 1912 for striking a girl while supervising bathing (Board of Management, 1910, pp. 156, 173; Board of Management, 1912, pp. 43, 221). Corporal punishment was allowed for the boys, but it was strictly regulated with at least two members of staff required to be on hand at the time of punishment. The committee was equally strict with this rule, forcing the resignation of the bandmaster after he struck a boy in anger in May 1915 and reprimanding the temporary chargemaster in September 1916 (Board of Management, 1912, p. 43; Board of Management, 1915, p. 96; Board of Management, 1916, p. 73). Unfortunately, even though the official punishment book survives, it does not include specific information about punishments for this period, so it is difficult to know how often corporal punishment was employed (*Punishment Book*, *n.d.*).

A final consideration is that the period studied here includes the first years of World War I, so a little must be said about how the institution faired during the war. The war was certainly disruptive, but the effects of the war on the children's health are smaller than might be expected. The war influenced the school in two main ways. First, the school's contractors were not able to obtain the same quality and brands of meat as they obtained before the war. The superintendent reported in May 1915 that "owing to the unprecedented shortage of British beef they [the contractors] would be compelled to supply Frozen or Colonial, if they could procure it, for Officers' Meat, and cannot be sure of procuring the particular brand of legs of Mutton" (Board of Management, 1915, p. 91). Thus, it seems that the superintendent was forced to feed the children poorer quality meat, but there is no indication that the quantity of meat served declined during the war. In addition, as mentioned above, the superintendent had no qualms in rejecting spoiled meat, so although the fat content of the meat was probably lower, the meat was probably still safe to eat. Second, the war took a toll on the school's labour force. Twelve officials were already "absent with the forces" in December of 1915 (Board of Management, 1915, p. 208). This loss of manpower was detrimental to the children's general behaviour with the superintendent and matron filing more and more negative reports over the course of the war. The board even broke with its strict policy of firing those inflicting elicit punishments in September 1916 by only reprimanding the temporary chargemaster for caning a boy rather than dismissing him. Likewise, in October 1916 the visiting committee reported that the water tanks could only be cleaned twice per year rather than quarterly because there was not sufficient manpower to clean the tanks so often (Board of Management, 1916, pp. 73, 78, 89). The decline in discipline and other problems related to the shortage of manpower could have influenced the children's health, but they seem rather small when compared to changes in diet, etc.

In conclusion, the children in the Marcella Street Home and the Ashford School satisfy both of the preconditions for catch-up growth. They were stunted in terms of height-for-age and weight-for-age upon entry to the institutions. And the conditions in the institutions were likely to be a significant improvement on the conditions they experienced in their homes before entering the institutions.

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

6.1 A Descriptive Look at Catch-up Growth in the Institutions

Having satisfied the preconditions for catch-up growth, we can now put the natural experiment to the test by measuring the children's longitudinal growth 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.[8] 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. This method assumes that the intervention that sparks catch-up growth is not age dependent but is instead dependent on the age at which the child enters the institution, which is random.

[8] 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.

Figures 18-20 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 12 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.

[Take in Table 12 here]

[Take in Figure Nos. 18, 19 and 20 here]

6.2 Modelling Catch-up Growth in a Multiple Regression Framework

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 21, girls in both the Marcella Street Home and Ashford School were growing much faster after the age of 13 than 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 (Figure 22). 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.

[Take in Figure Nos. 21 and 22 here]

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 spentin the institution is included to control for any differences between children who may have stayed in the institution longer than others.[9] 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.[10] 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 instead programmed based on genetic factors and environmental conditions during foetal and early life development (Godfrey *et al.*, 2007; Gluckman and Hanson, 2006, pp. 6-8). 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 in the regressions since it seems to be scientific best practice (Walker *et al.*, 1996, p. 3019).

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

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[9] Correlations between the height-for-age Z-score at admission and the length of time spent in the institutions were very low and insignificant. The natural log of the time in the institution was also included in the regressions, but the results were unaffected.

[10] Height-for-age Z-scores and BMI-for-age Z-scores were not highly correlated, so there are no potential problems with multicolinearity in the regressions.

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 (2010a; 2010b) have found that children with more siblings were shorter than their counterparts with fewer siblings because larger families had to spread limited resources across more individuals, so it is important to attempt to control for this effect. 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 simplest specification 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. These variables were kept separate rather than combining them into a parent death dummy variable because the effect of having a dead father or a dead mother could have been different. Without a father, the family would lose a major source of income in the household, but without a mother, the children might not have someone to take care of them and to bargain for them when household resources were allocated (Horrell and Oxley, 2013). Testing these effects separately could provide an interesting way of measuring whether the income loss from a dead father was worse for children's health than the care and bargaining loss from a dead 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 (*Marcella Street Home Register*, *n.d.*). These boys and girls came from a different background than their counterparts and were also significantly older than the average child entering the school: the mean age of truant boys and girls at admission was 11.81 and 12.07 respectively whereas the mean age of other boys and girls in the school at admission was 7.99 and 7.55 respectively. 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.

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. As mentioned above, calculating the Z-score compared to modern standards for each child implicitly assumes that the children followed a modern growth curve, but this was clearly not the case. Both boys and girls grew at a slower rate for a longer period of time and had later pubertal growth spurts than modern populations. In order to control for these effects, it is necessary to introduce sex and age interaction variables. Thus, ages were grouped into one-year increments and interacted with the sex dummy variable. However, simply including full interactions and then interpreting the sex dummy in the regression is problematic since the sex dummy will only refer to the reference group. Thus, the more complex specifications (specifications 2-5) exclude the sex dummy variable and report the age-sex interaction terms only. These interaction terms show the catch-up of boys relative to girls at each age so that if the coefficient is negative, boys are experiencing slower catch-up growth relative to girls.

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 populations and children, the time invariant change, than the specific factors that could have affected individual children's growth while they were in the institution. 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 by the record keeper. 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 each school, 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 height change regressions.

6.3 Catch-up Growth Regression Results

Beginning with the change in height Z-score regressions (Tables 13 and 14), there are a number of interesting factors that help to explain children’s longitudinal growth during the late nineteenth and early twentieth century. In both the Marcella Street Home and the Ashford School, there was regression to the mean in children’s growth. Children who entered the institution short for their age experienced more catch-up growth than their taller 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. 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 truant children were drawn from a more diverse class background and were slightly better off than the rest of the children in the Home.

[Take in Table 13 and 14 here]

Finally, turning to the results by gender, the coefficients on the sex-age interaction variables were only statistically significant after the age of twelve or thirteen when girls were beginning to have their pubertal growth spurt and boys were falling behind in terms of modern standards since they had not yet entered their pubertal growth spurt. Figures 23 and 24 present this information graphically by plotting the coefficients along with their 95 per cent confidence intervals. Although the coefficients tend to be negative (favouring girls), they are not statistically significant. This suggests that there were no large gender disparities in health between boys and girls in the two institutions. This result and its implications will be discussed in detail in the next section.

[Take in Figure Nos. 23 and 24 here]

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 A1-A4). I have included the regression tables in an appendix for the sake of completeness, but there are very few concrete lessons to draw from these results. In both cases regression to the mean was still significant and negative in the regressions. Children who entered the institution with lower BMI-for-age Z-scores were more likely to catch-up in terms of weight-for-age or BMI-for-age than their fatter counterparts. 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. 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, there were no consistent findings of gender bias in weight-for-age or BMI-for-age Z-score growth.

7. Catch-up Growth and Gender Disparities in Health

As mentioned above, the main finding from the catch-up growth regressions was that boys and girls experienced similar levels of catch-up growth in terms of height in both the Marcella Street Home and the Ashford School controlling for difference between modern and historical growth curves. This finding is consistent in many ways with the current literature. It concurs with the household budget literature, which found no gender discrimination in resource allocation among upper working class families in Britain and the US. It also helps to substantiate Harris's findings of ambiguous differences in growth between boys and girls in early twentieth century Britain and his findings that girls did not have substantially higher mortality rates than boys across the second half of the nineteenth and twentieth centuries (Horrell and Oxley, 1999; Logan, 2010; Harris, 1998; Harris 2008).

Although the results mostly confirm arguments in the literature, they do extend knowledge about children's welfare in the late nineteenth and early twentieth centuries in two respects. First, this paper has tested whether gender disparities in health existed among lower working class and impoverished children. As has been argued above, earlier studies focused mostly on upper working class and middle class schoolchildren or families (Haines, 1981, pp. 245-9; Horrell and Oxley, 1999, p. 499). However, the children in the two schools were likely from the poorer echelons of the working class. Thus, it does not appear that families closer to poverty made systematic decisions to underinvest in the health of their daughters or sons.

Second, this study also provides a warning that cross-sectional comparisons of children's heights at certain ages are a potentially problematic measure of gender disparities in health. As mentioned above, Harris's cross-sectional evidence of relatively well-off schoolchildren suggested that girls in Britain before the First World War had a height percentile advantage between the ages of five and nine with boys taking the advantage after the age of twelve (Harris, 1998, p. 427). This pattern, however, is more a function of growth curves than anything else. Remember that the distribution of height-for-age Z-scores at admission to the Ashford School for boys and girls were nearly identical (see figure 13 above). Yet despite these similarities when all ages are combined, the pattern is different when boys and girls' height-for-age Z-scores at admission are plotted against their age (figure 25). The data confirm Harris's finding that girls tended to be taller relative to modern standards between the ages of 7 and 9 and boys tended to be taller than girls relative to modern standards between the ages of 10 and 12.

[Take in Figure No. 25 here]

However, these differences do not tell us anything about the relative well-being of boys and girls because they mostly reflect the earlier pubertal growth spurt in modern populations. If the children were perfectly following the modern growth curve, then we would expect the lines in figure 25 to be perfectly flat though at a lower Z-score. This would suggest that children were following their canalized growth trajectory across different ages. However, the lines in figure 25 are decidedly not flat because of the differences between historical and modern growth curves. The girls' height-for-age Z-scores decline from ages 9 to 12 because modern populations of girls, the reference, experience their pubertal growth spurt at those ages, whereas the historical population of girls continue growing at a lower, pre-adolescent growth spurt rate and fall behind their modern counterparts. We can observe the same phenomenon for boys. The modern population begins its pubertal growth spurt at age 12 while the historical population has a much later growth spurt, which causes the boys' height-for-age Z-score to fall.

These insights highlight several problems with studying children's historical growth patterns in a cross-sectional framework. First, as mentioned above, the height-for-age Z-score or percentile differences between boys and girls at specific ages are strongly influenced by the timing of the pubertal growth spurt in historical and modern populations. This also highlights the fact that boys and girls need to be studied separately in cross-section because pooling the boys and girls would produced skewed results even if there were equal number of girls and boys in the sample. Second, it is very difficult to accurately disentangle catch-up growth from the different timing of the pubertal growth spurt by looking at cross-sectional data alone. This does not discount all studies that have inferred catch-up growth from cross-sectional data. For instance, Steckel's (1986, p. 724) finding that American slave boys were at the 0.2 percentile of modern standards at age 4.5 and at the 27th percentile by the time they were adults certainly implies substantial catch-up growth. However, it is important to consider whether we are measuring catch-up growth or merely observing a slower velocity of growth for a longer period of time. In order for type B catch-up growth to occur, the population must surpass their earlier level of growth. Thus, they must reach a higher height-for-age Z-score at adulthood than they reached before the Z-scores declined during the modern pubertal growth spurt. An extension of the growing years into the twenties or solely an increase in height-for-age Z-scores after age 14, therefore, is not definitive evidence of catch-up growth because we would not know whether the children's height-for-age Z-scores exceeded their level before the dip caused by differences between the timing of the pubertal growth spurt in modern and historical populations.

Finally, time series of children's height-for-age Z-scores or percentiles at a specific age, such as those presented by Harris (2009, pp. 69-70; 1998, p. 429), are interesting for tracking changes in children's growth over time, but an increase in height-for-age Z-scores especially during the pubertal growth spurt ages cannot in and of itself be taken to show improving child nutrition. This is because increases in the height-for-age Z-score could indicate improvements in child health, or they could merely reflect the fact that the historical and modern pubertal growth spurts were becoming more closely aligned. Looking at the case of girls in the Ashford School in figure 25, it is clear that as the pubertal growth spurt began earlier across the twentieth century, girls at ages 10-12 would experience larger increases in their height-for-age Z-scores than girls at other ages because they would not fall behind as much during the pubertal growth spurt. Therefore, it would be difficult to know whether the timing of the increase in height-for-age Z-scores at these ages was related to changes in the socio-economic circumstances of these children or merely changes in the pattern of growth as the height-for-age curves (in figure 25) simultaneously increased at all ages and shifted from a curve with a hole around the pubertal growth spurt toward the flat, canalized growth trajectory of modern populations.[11]

Although this study has failed to uncover systematic differences in catch-up growth between boys and girls, it still presents a useful methodology that could be replicated in other settings to understand gender differences in health. It also highlights how longitudinal growth measurements can enrich our understanding of how the growth pattern of children has changed over time. Clearly, collecting more

[11] It should be noted that an earlier pubertal growth spurt could be in itself an indicator of good child health.

longitudinal measures of children's growth could be a very helpful way of moving forward.

8. Conclusion

The evidence presented in this paper suggests that the boys and girls entering the Marcella Street Home and the Ashford School experienced similar levels of catch-up growth, suggesting that boys and girls were more or less equally healthy in the period before entering the institution. If there were large differences in their access to nutrition, their disease morbidity or their work levels, we would have expected to see differences in their growth. Thus, there were not strong health disparities between boys and girls in Britain and the United States in the late nineteenth and early twentieth centuries even when studying impoverished and lower working class populations not analysed before.

These findings are significant for a number of reasons. First, they suggest that there was no discrimination against girls in the allocation of household resources in this period, at least in resources that would influence growth. If families had given boys better access to nutrition, then girls should have experienced greater catch-up growth across many ages. Since we do not observe this, it seems likely that boys and girls were given access to nutrition commensurate to their needs or at least the deprivation that these children faced was not targeted toward girls.

In addition, the results suggest that the health disparities between men and women in the late nineteenth and early twentieth centuries found in some studies arose in adulthood. Thus, there are two possible causes of gender disparities in adult health. There could have been an earner bias so that resources were allocated based on income brought into the family as Horrell and Oxley (2013) have suggested. Or it is possible that women sacrificed their own consumption (to a larger extent than their husbands) in order to provide their children with adequate resources. In fact, if mothers sacrificed their own consumption to give additional food to their daughters, they could have displaced any discrimination in the allocation of household resources that might have occurred. These gender disparities in adult health were still important; they just did not arise as a product of poor conditions during childhood.

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Appendix

[Take in Tables A1-A4 here]

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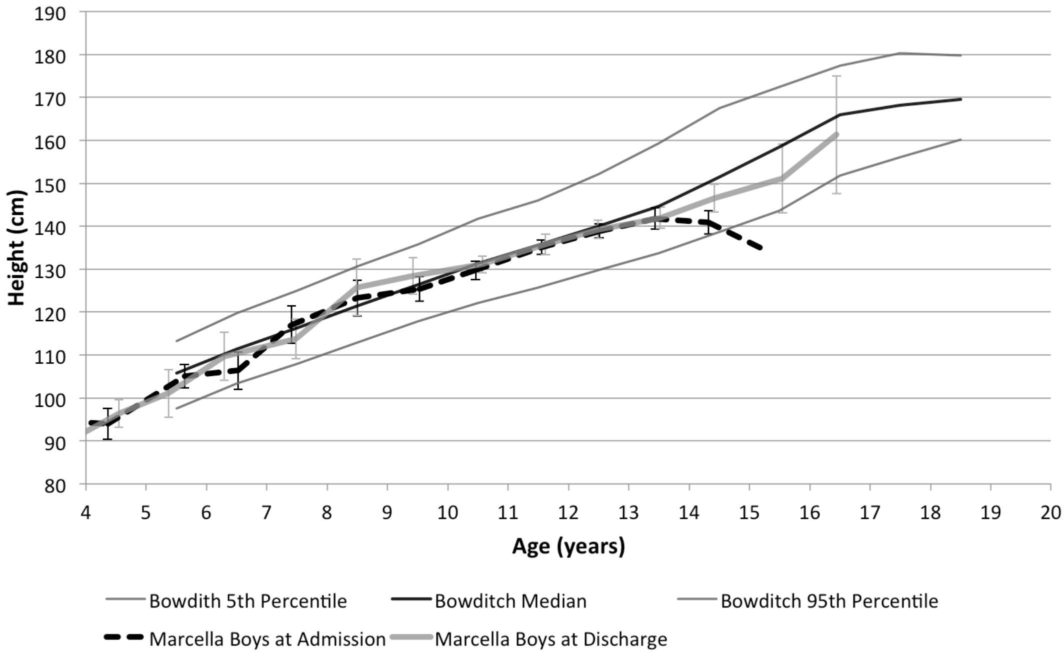
Figures

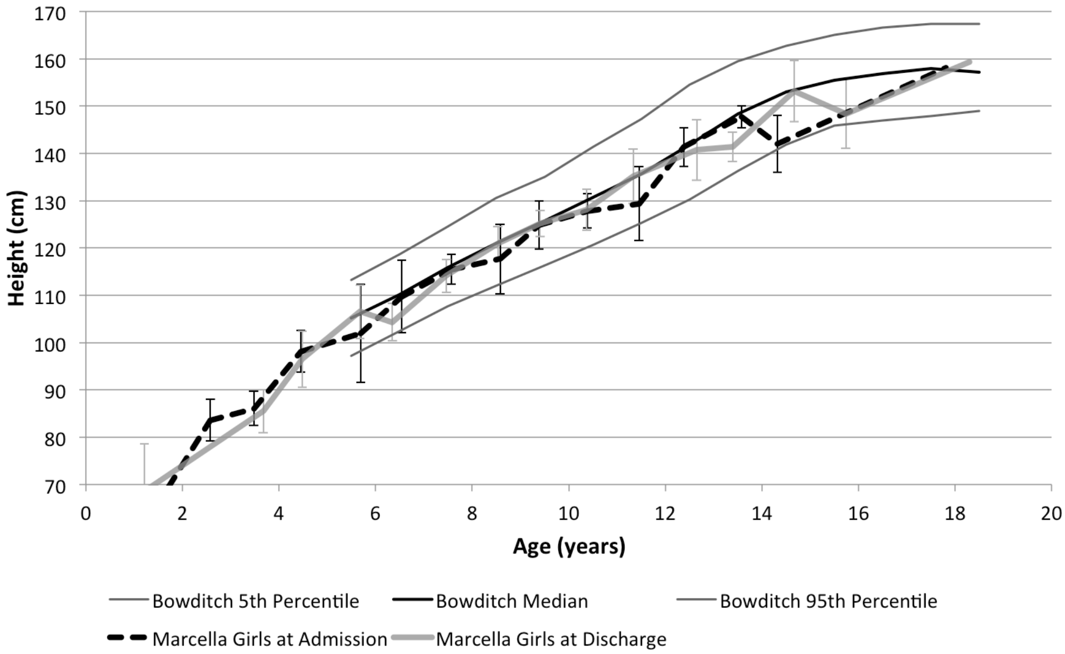
Figure 1: Comparison of heights of boys in the Marcella Street Home (1889-98) with Bowditch's sample of Boston schoolboys measured in the 1870s.



Notes: Error bars are 95 per cent confidence intervals for the mean height of boys at each age.

Sources: *Marcella Street Home Register* (n.d.); Bowditch (1891, p. 482).

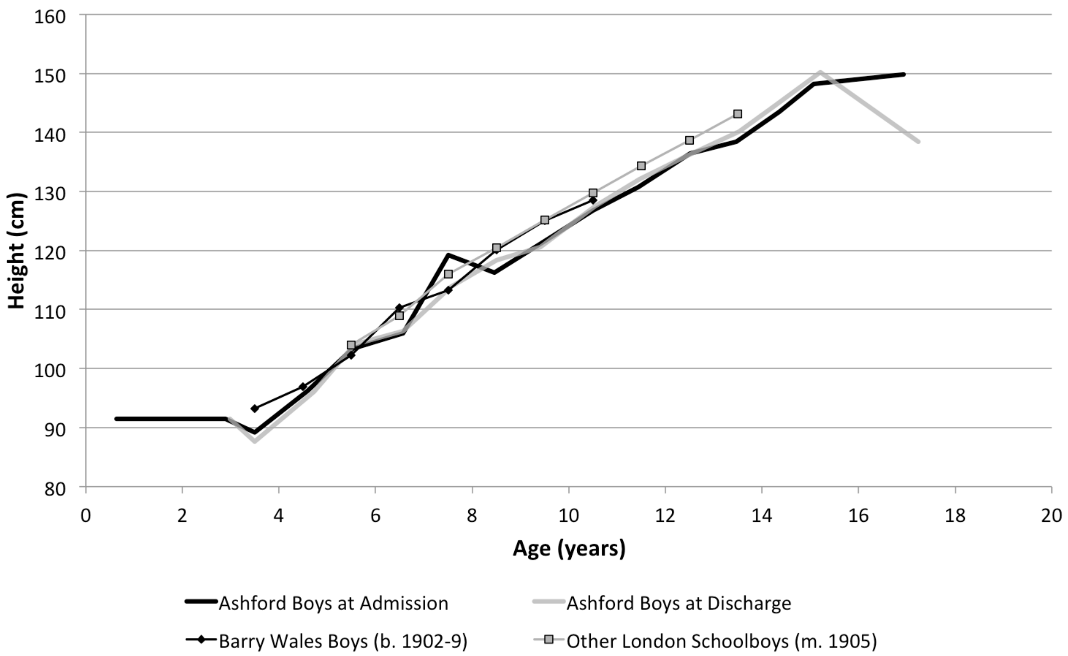
Figure 2: Comparison of heights of girls in the Marcella Street Home (1889-98) with Bowditch's sample of Boston schoolgirls measured in the 1870s.



Notes: Error bars are 95 per cent confidence intervals for the mean height of girls at each age.

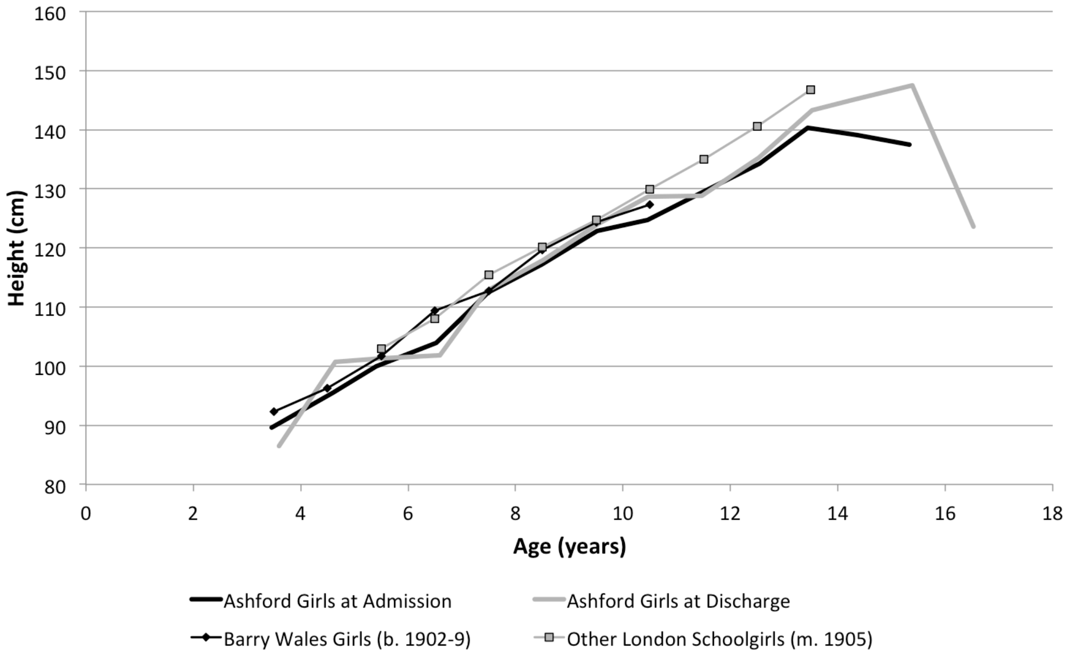
Sources: *Marcella Street Home Register* (n.d.); Bowditch (1891, p. 488).

Figure 3: Comparison of heights of boys in the Ashford School (1908-16) with samples of schoolboys from Barry, Wales (1902-9) and London (1905).



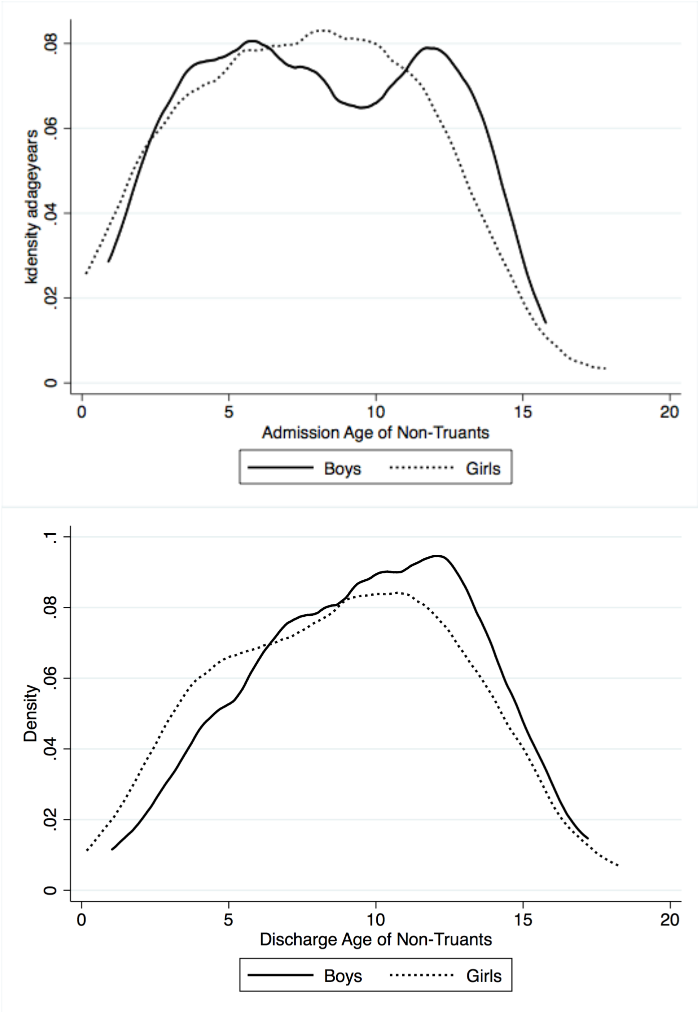
Sources: Medical Officer's Report Book (n.d.); Habakkuk (1926, p. 300); Cameron (1979, p. 514).

Figure 4: Comparison of heights of girls in the Ashford School (1908-16) with samples of schoolgirls from Barry, Wales (1902-9) and London (1905).



Sources: see figure 3.

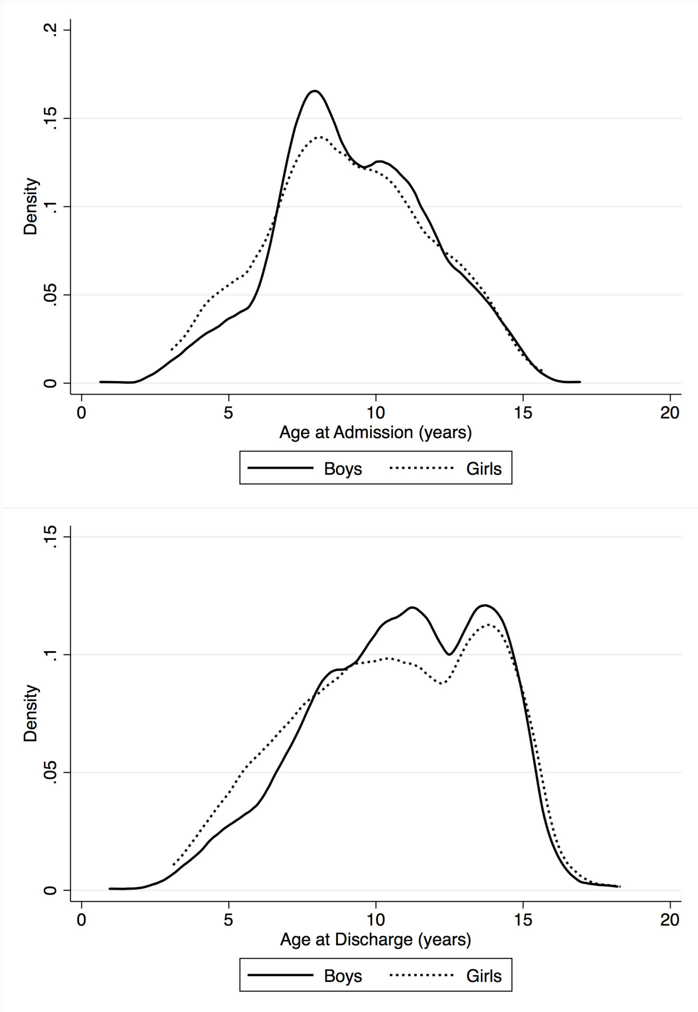
Figure 5: Admission and discharge age distributions for boys and girls in the Marcella Street Home



Notes: Truant children were admitted through a separate process and were slightly different than children entering the Marcella Street Home through the regular admissions process.

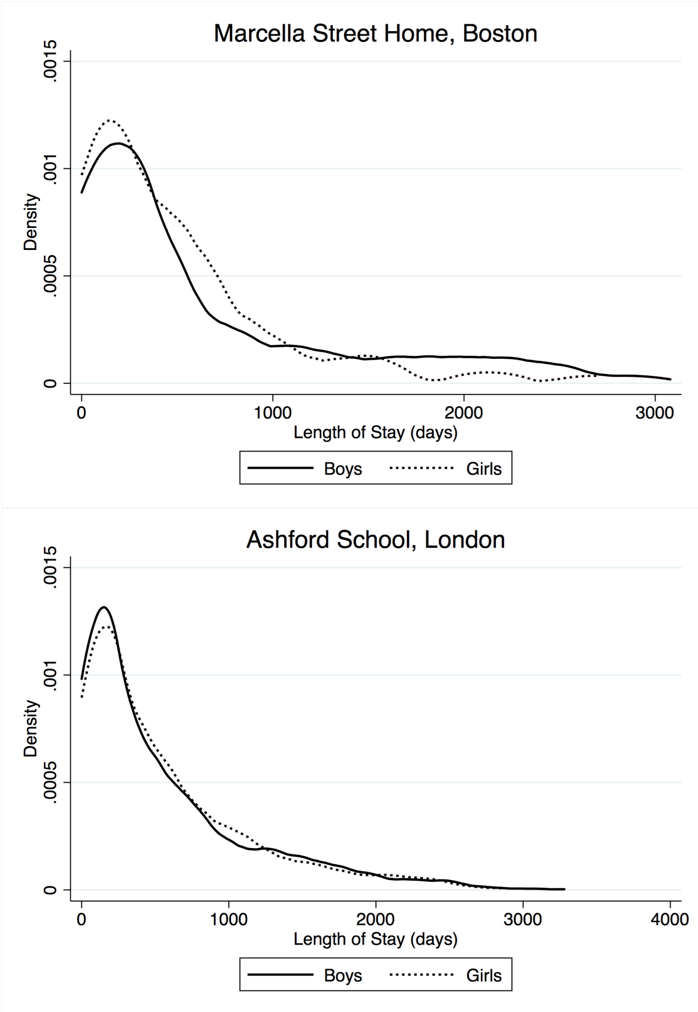
Sources: *Marcella Street Home Register* (n.d.).

Figure 6: Admission and discharge age distributions for boys and girls in the Ashford School



Sources: *Medical Officer's Report Book* (n.d.).

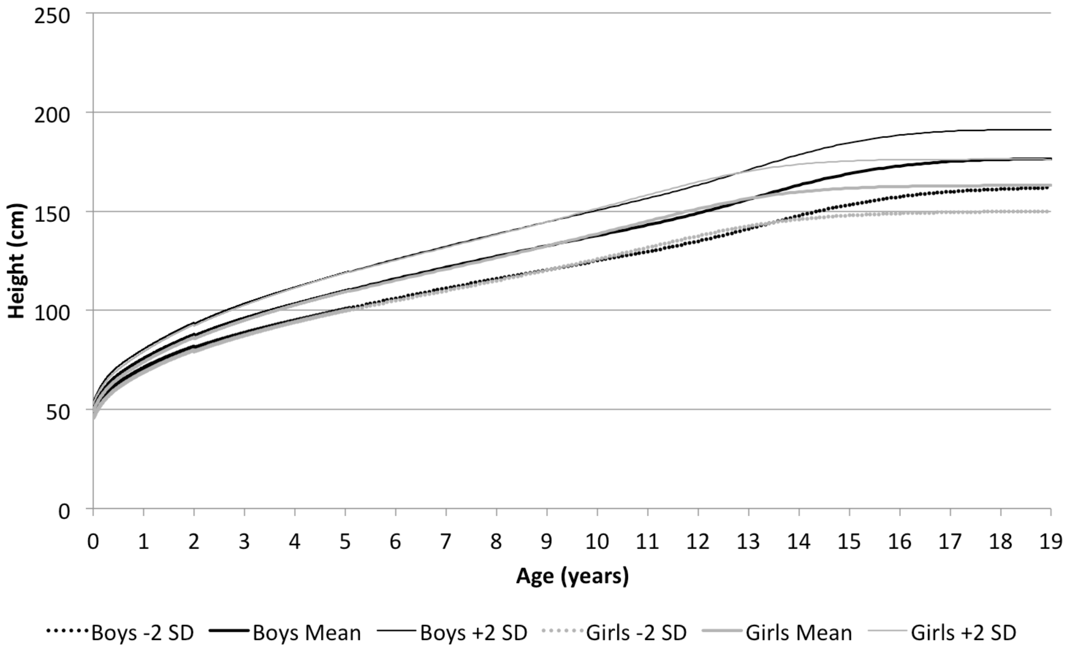
Figure 7: Length of stay by gender of non-truant children in the Marcella Street Home (left) and all children in the Ashford School (right)



Notes: Truant children were admitted through a separate process and were slightly different than children entering the Marcella Street Home through the regular admissions process.

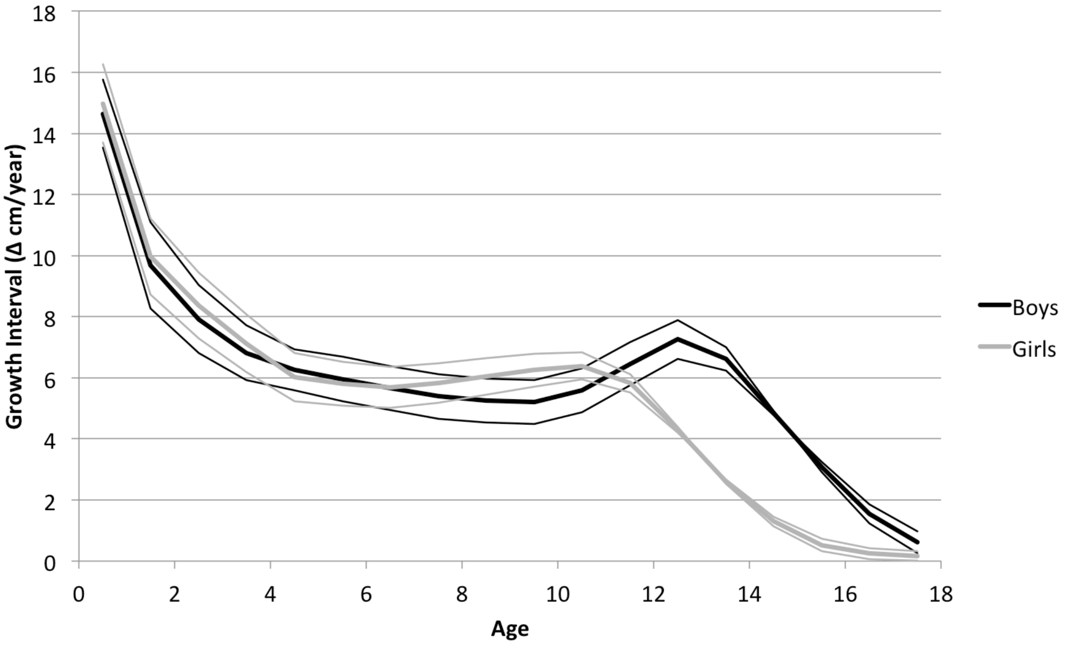
Sources: *Marcella Street Home Register* (n.d.); *Medical Officer's Report Book* (n.d.).

Figure 8: 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.* (2007); WHO, 2006); data drawn from http://www.who.int/growthref/en/.

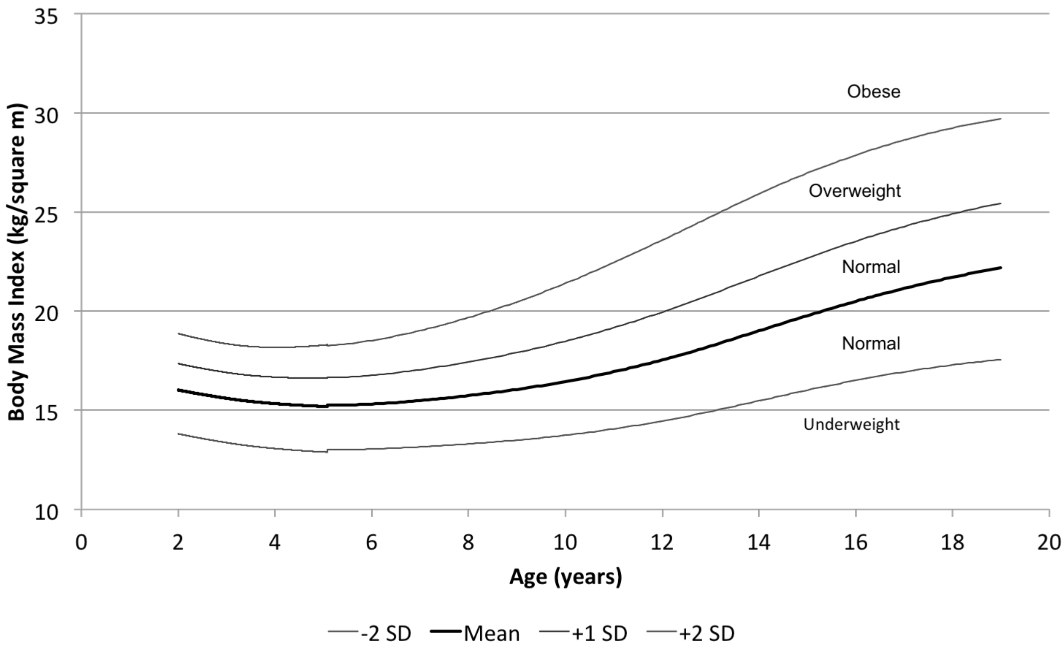
Figure 9: Growth velocity (height intervals) for modern children according to the WHO 2006/7 growth references.



Notes: The middle line is the height interval at the mean of the distribution and the fine lines above and below this represent the velocity at plus and minus two standard deviations from the mean.

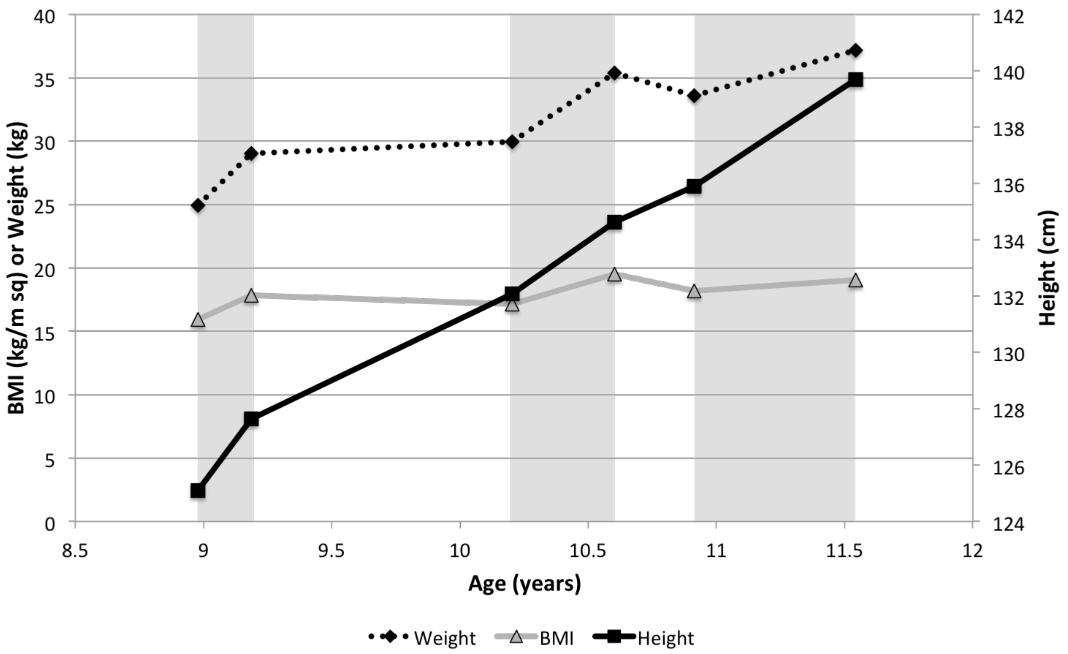
Sources: de Onis *et al.* (2007); WHO, 2006); data drawn from http://www.who.int/growthref/en/.

Figure 10: WHO 2006/7 BMI-for-age standards for modern, healthy children.



Sources: de Onis *et al.* (2007); WHO, 2006); data drawn from http://www.who.int/growthref/en/.

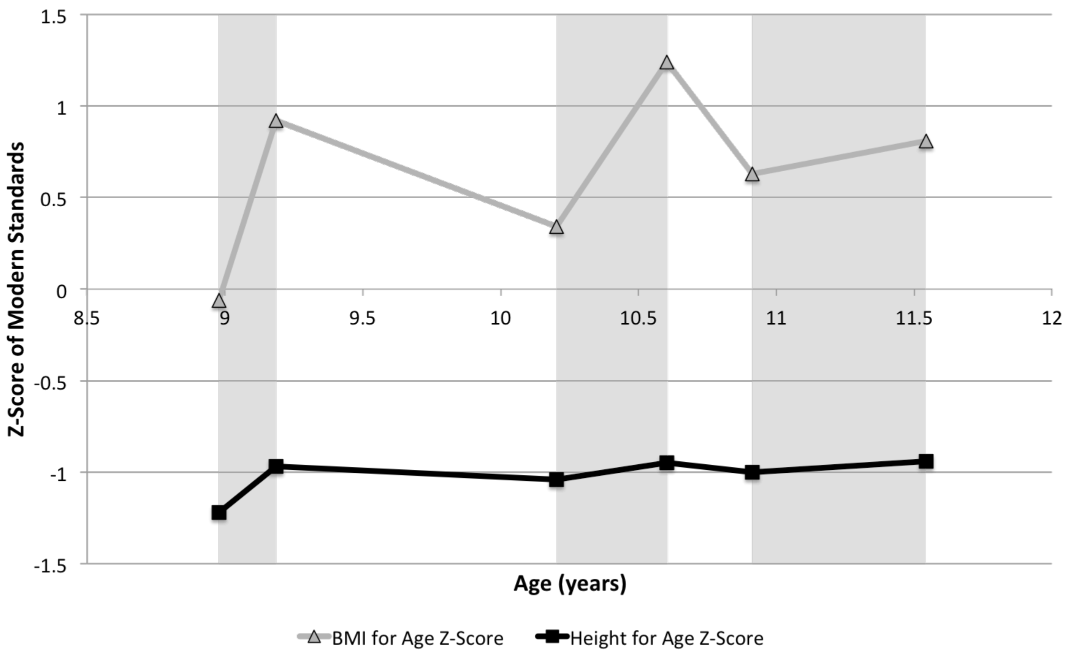
Figure 11: Height, weight and BMI growth of Daniel O'Brien in the Marcella Street Home, Boston Massachusetts, 1892-4.



Notes: Gray shaded periods are the ages in which Daniel was in the Marcella Street Home.

Sources: Marcella Street Home Register (n.d.).

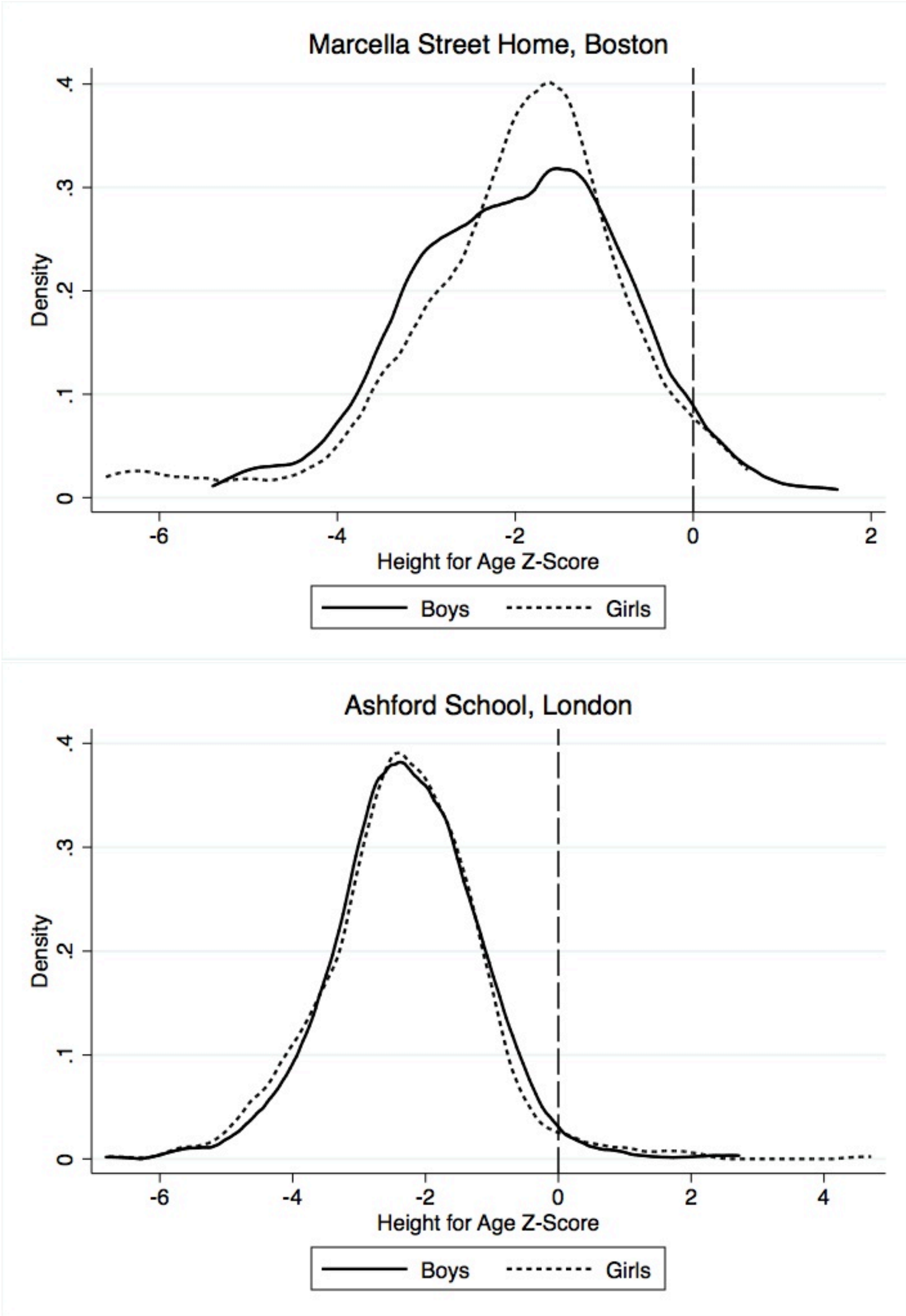
Figure 12: Height and BMI growth as Z-scores of modern standards of Daniel O'Brien in the Marcella Street Home, Boston Massachusetts, 1892-4.



Notes: Gray shaded periods are the ages in which Daniel was in the Marcella Street Home.

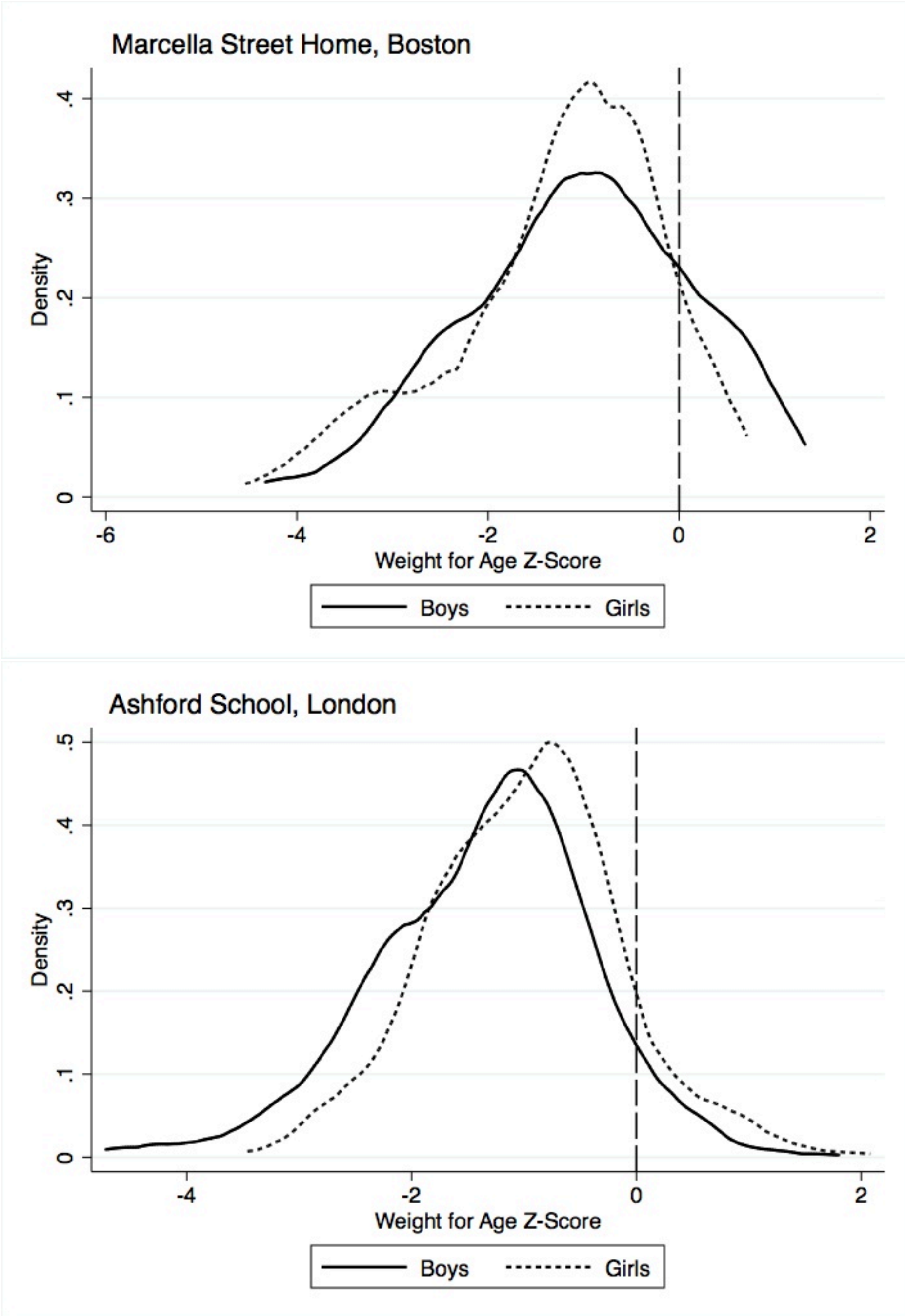
Sources: Marcella Street Home Register (n.d.).

Figure 13: Height-for-age Z-score distributions for children at admission to each school.



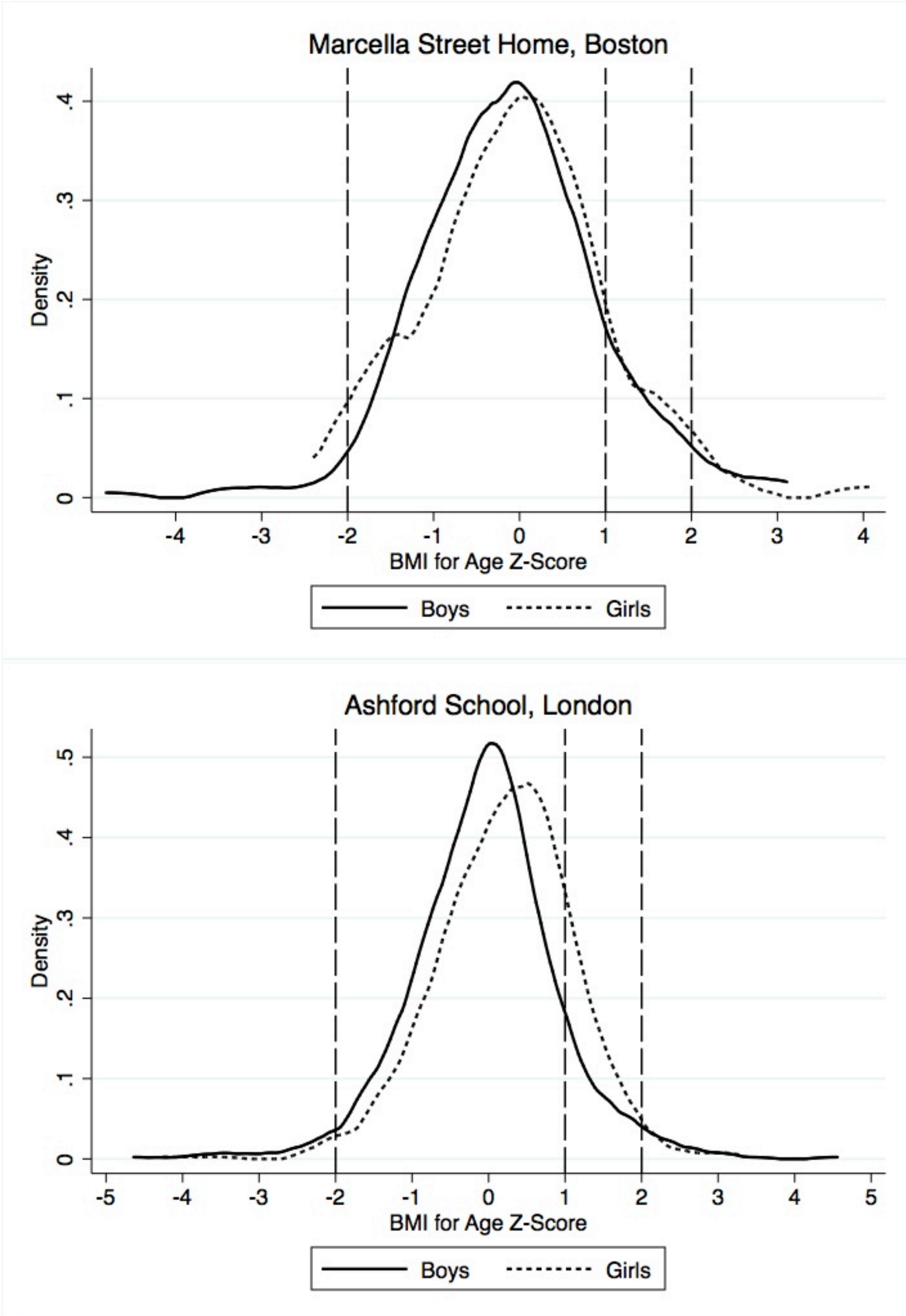
Sources: CBA, Marcella Street Home Register of Sentenced Inmates, 1877-1898, ref. 8503.001; London Metropolitan Archives (LMA), West London School District, Medical Officer's Report Book, WLSD/435.

Figure 14: Weight-for-age Z-score distributions for children at admission to each school.



Sources: Marcella Street Home Register (n.d.); *Medical Officer's Report Book* (n.d.).

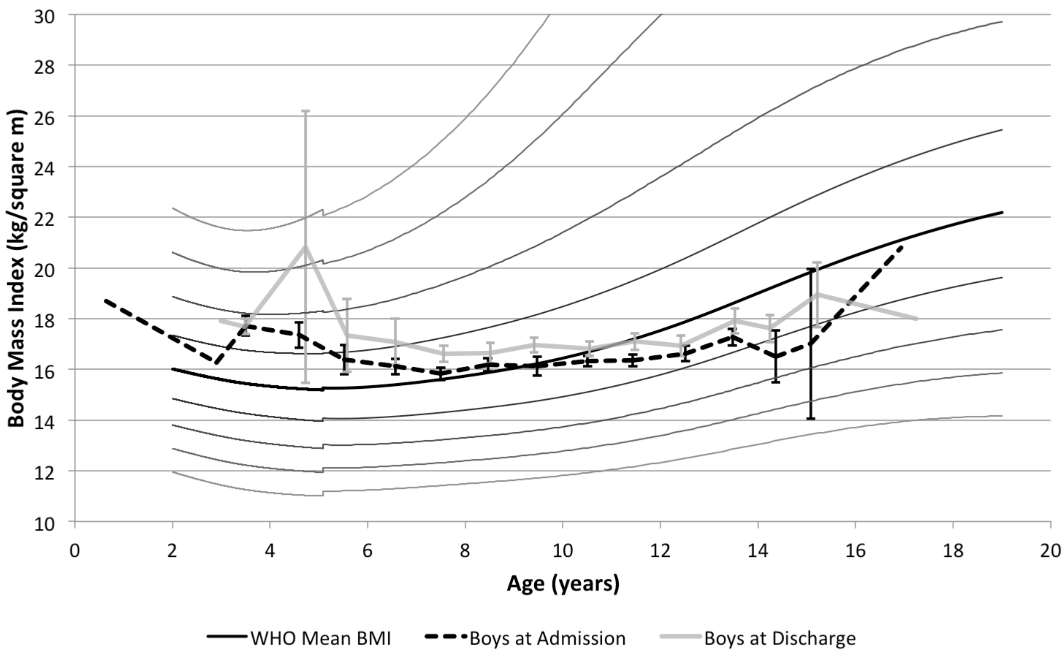
Figure 15: BMI-for-age Z-score distributions for children at admission to each school.



Notes: The dashed vertical lines show the cut off points for different weight categories: under -2 is underweight, -2 to 1 is normal, 1 to 2 is overweight, and over 2 is obese.

Sources: Marcella Street Home Register (*n.d.*); *Medical Officer's Report Book* (*n.d.*).

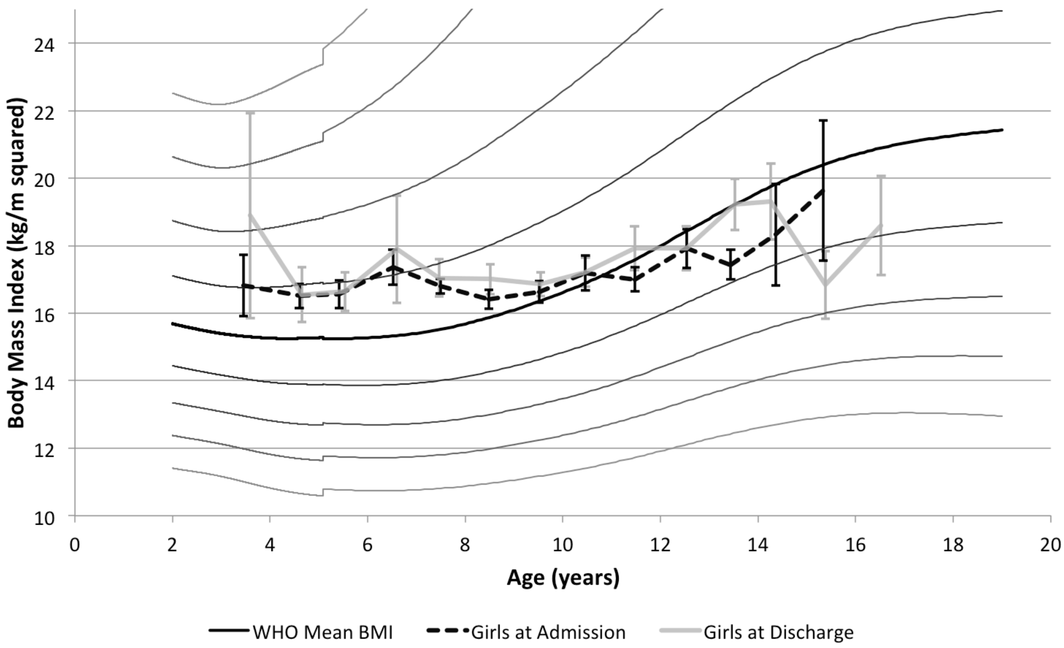
Figure 16: Comparison of modern BMI-for-age growth curves with the observed BMI-for-age cross-sectional growth curves for boys in the Ashford School.



Notes: The black solid line represents the mean BMI-for-age growth curve of the WHO 2006/7 growth references. The thin lines above and below the mean are standard deviations from the mean. 95 per cent confidence intervals are provided around the mean BMI of boys in the Ashford School at each age.

Sources: *Medical Officer's Report Book* (n.d.). de Onis *et al.* (2007); WHO, 2006); data drawn from http://www.who.int/growthref/en/.

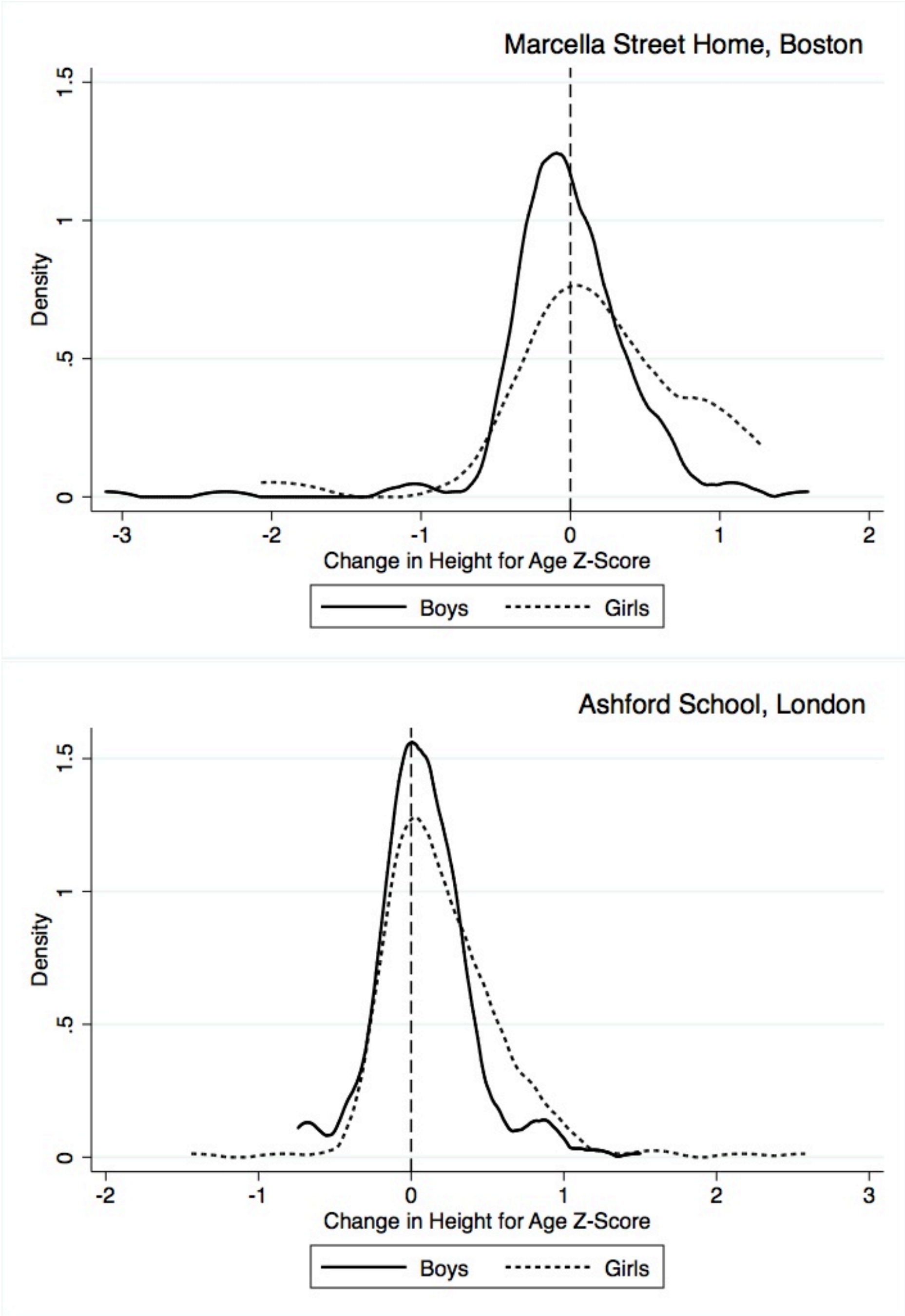
Figure 17: Comparison of modern BMI-for-age growth curves with the observed BMI-for-age cross-sectional growth curves for girls in the Ashford School.



Notes: The black solid line represents the mean BMI-for-age growth curve of the WHO 2006/7 growth references. The parallel lines above and below the mean are standard deviations from the mean. 95 per cent confidence intervals are provided around the mean BMI of girls in the Ashford School at each age.

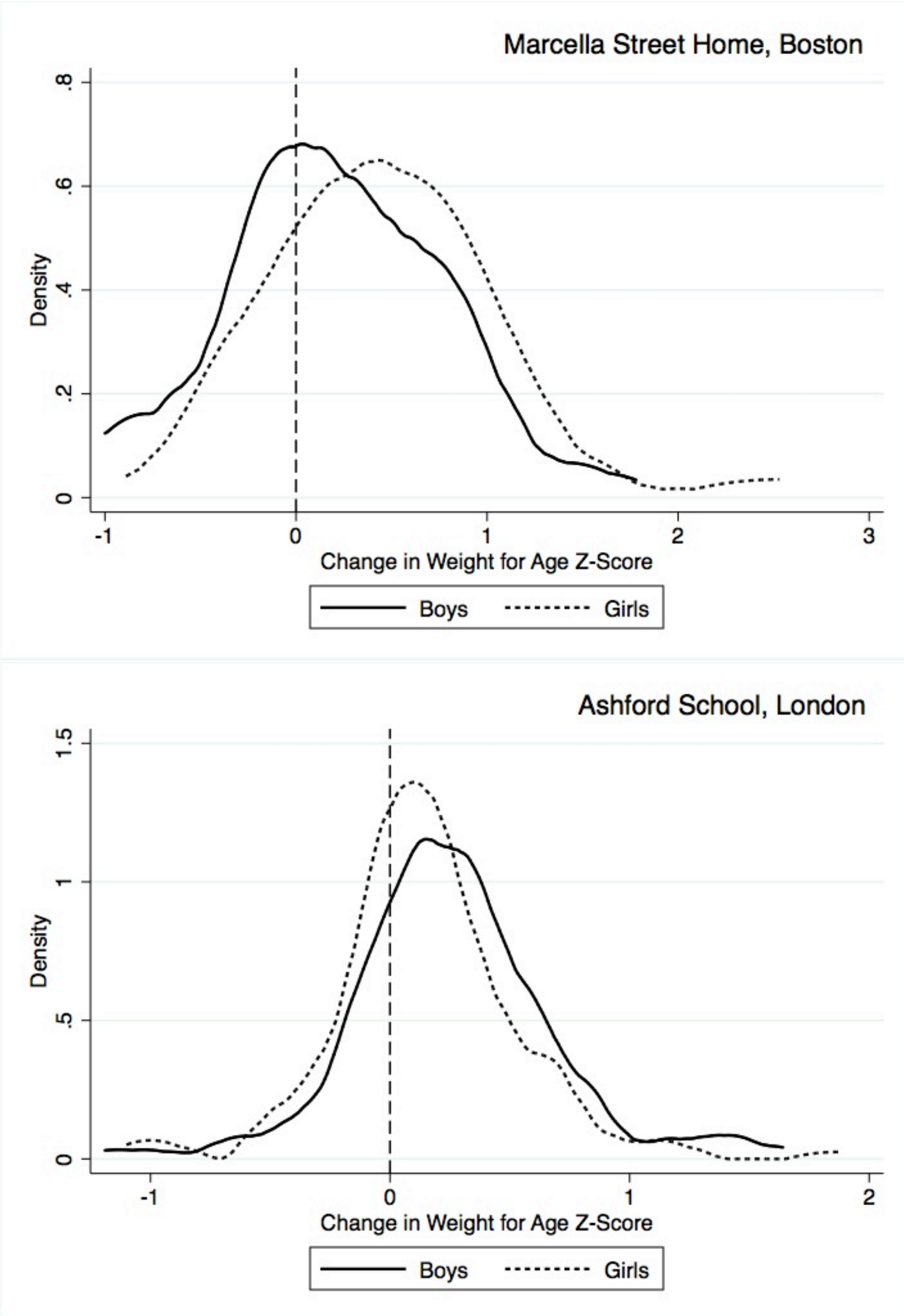
Sources: *Medical Officer's Report Book* (n.d.). de Onis *et al.* (2007); WHO, 2006); data drawn from http://www.who.int/growthref/en/.

Figure 18: 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.



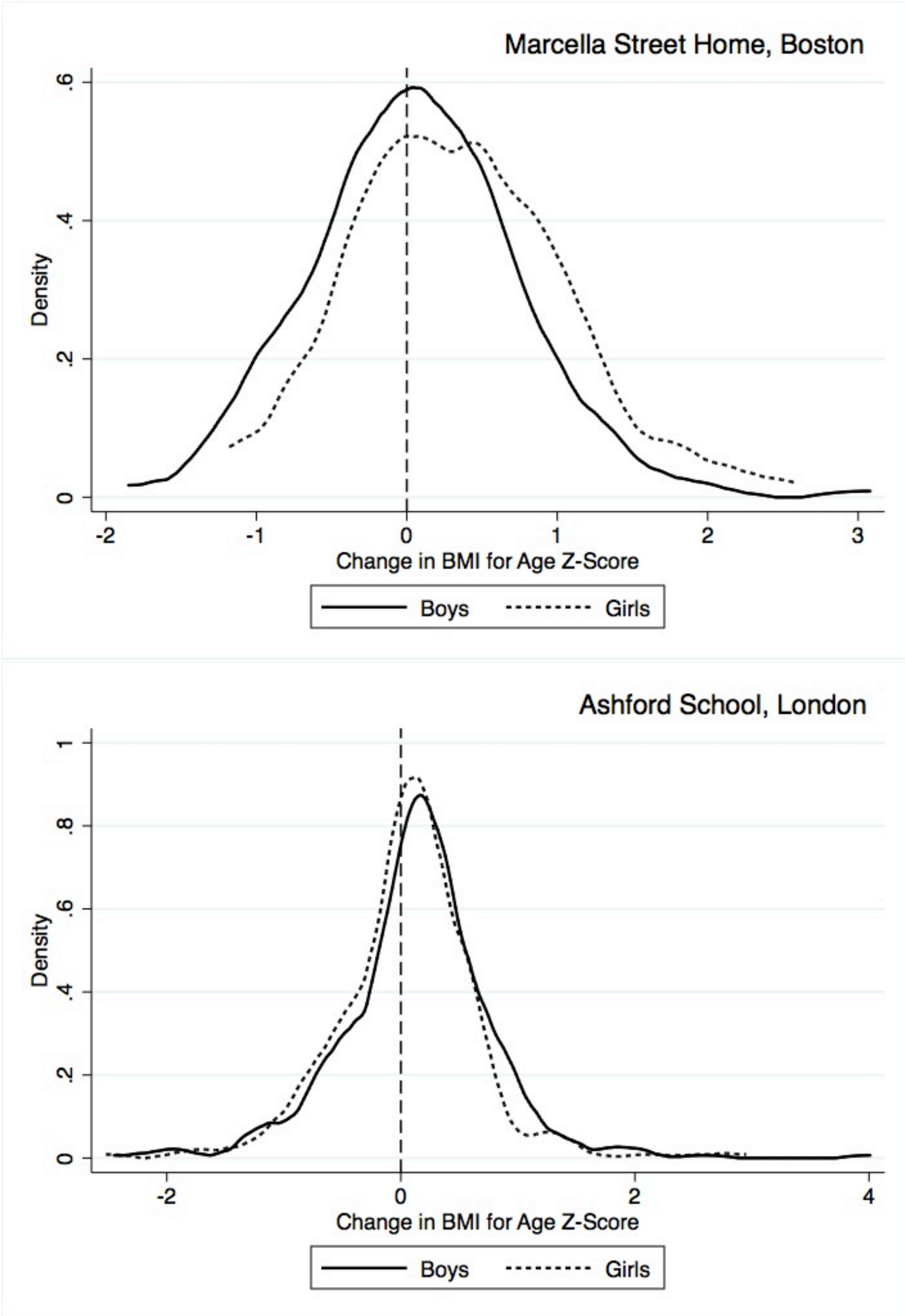
Sources: Marcella Street Home Register (*n.d.*); *Medical Officer's Report Book* (*n.d.*).

Figure 19: 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.



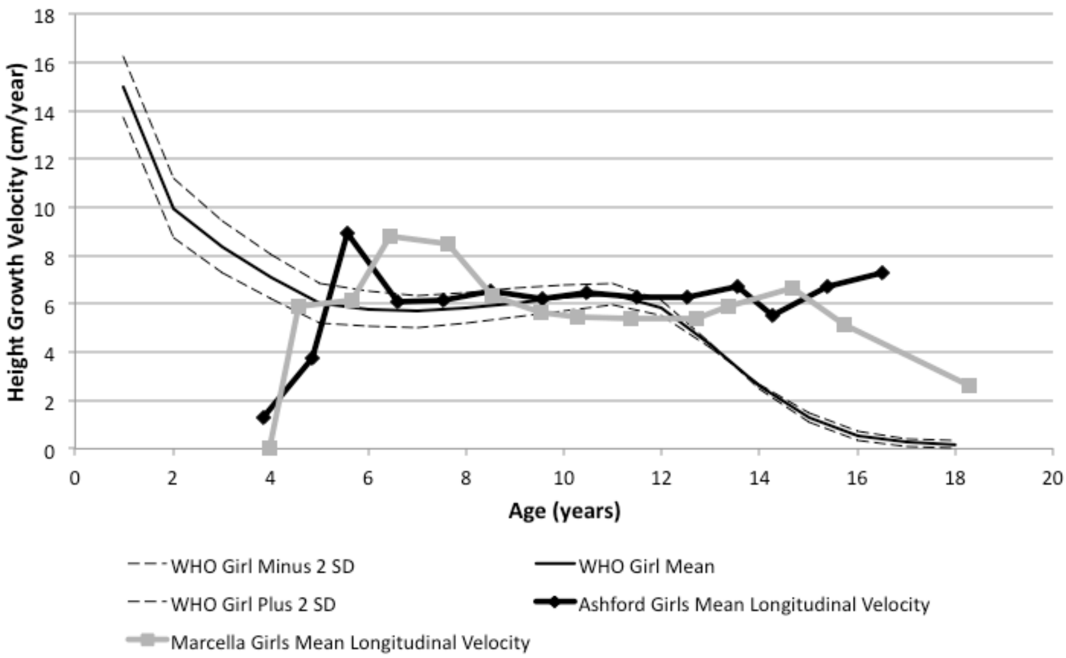
Sources: Marcella Street Home Register (*n.d.*); *Medical Officer's Report Book* (*n.d.*).

Figure 20: 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.



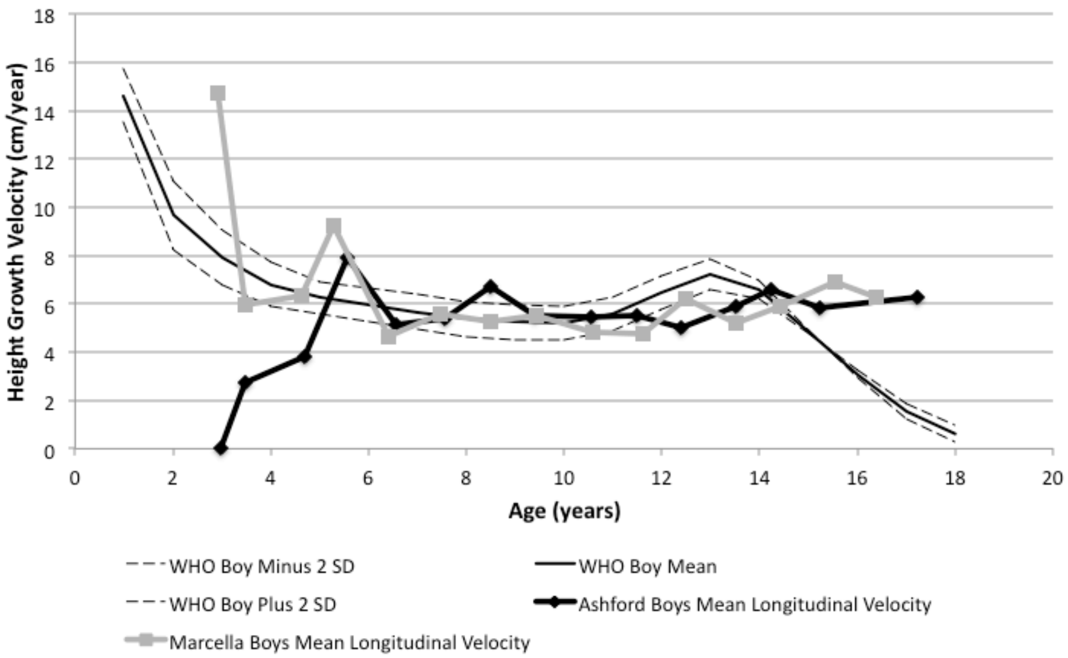
Sources: Marcella Street Home Register (*n.d.*); *Medical Officer's Report Book* (*n.d.*).

Figure 21: Longitudinal growth velocity of girls in the Marcella Street Home, Boston and the Ashford School, London compared with modern growth velocity curves



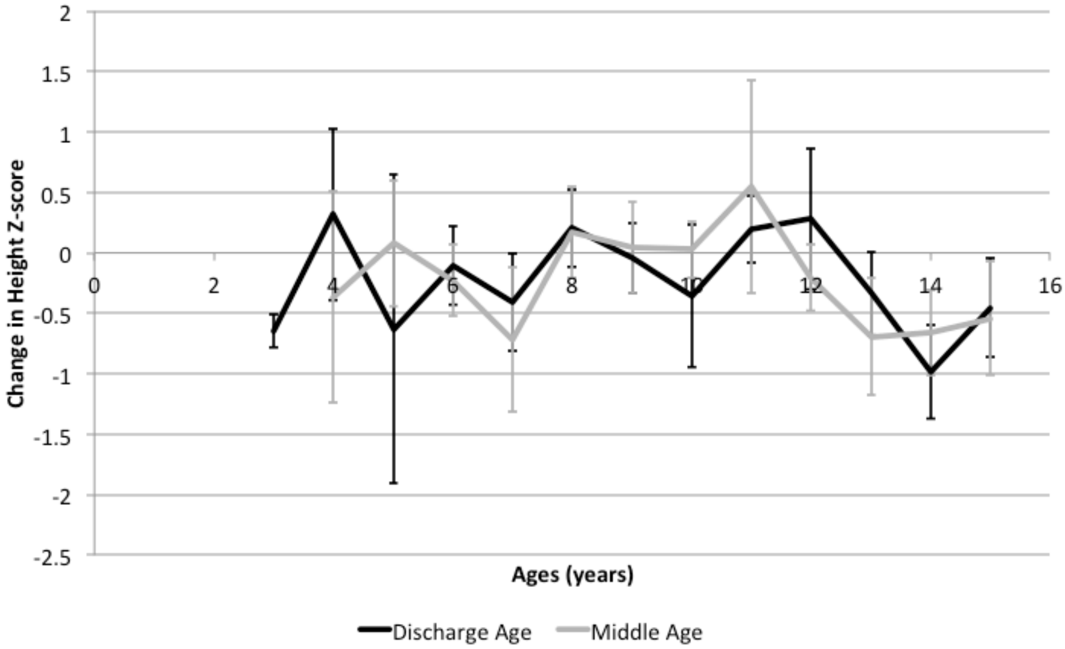
Sources: *Marcella Street Home Register* (*n.d.*); *Medical Officer's Report Book* (*n.d.*); WHO growth reference data drawn from http://www.who.int/growthref/en/.

Figure 22: Longitudinal growth velocity of boys in the Marcella Street Home, Boston and the Ashford School, London compared with modern growth velocity curves



Sources: see figure 21.

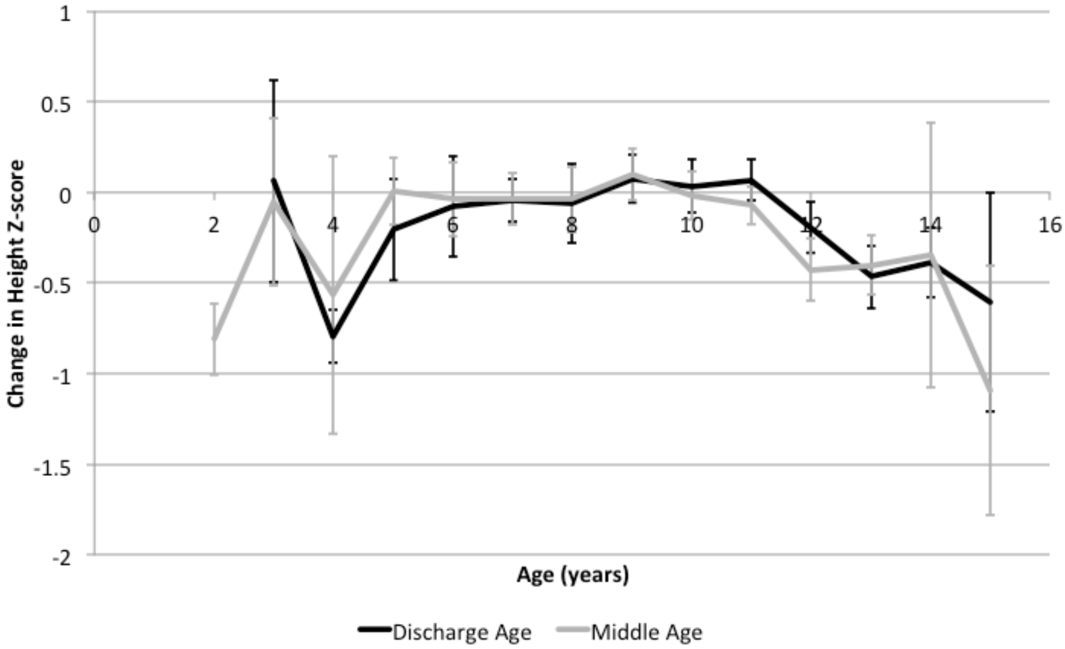
Figure 23: Predicted differences in catch-up growth between boys and girls in the Marcella Street Home, Boston, MA.



Notes: Regression coefficients from table 13 specifications 2 and 4 with 95 per cent confidence intervals. Positive coefficients suggest that boys were growing faster than girls and negative coefficients the opposite. See text for more details.

Sources: *Marcella Street Home Register* (*n.d.*).

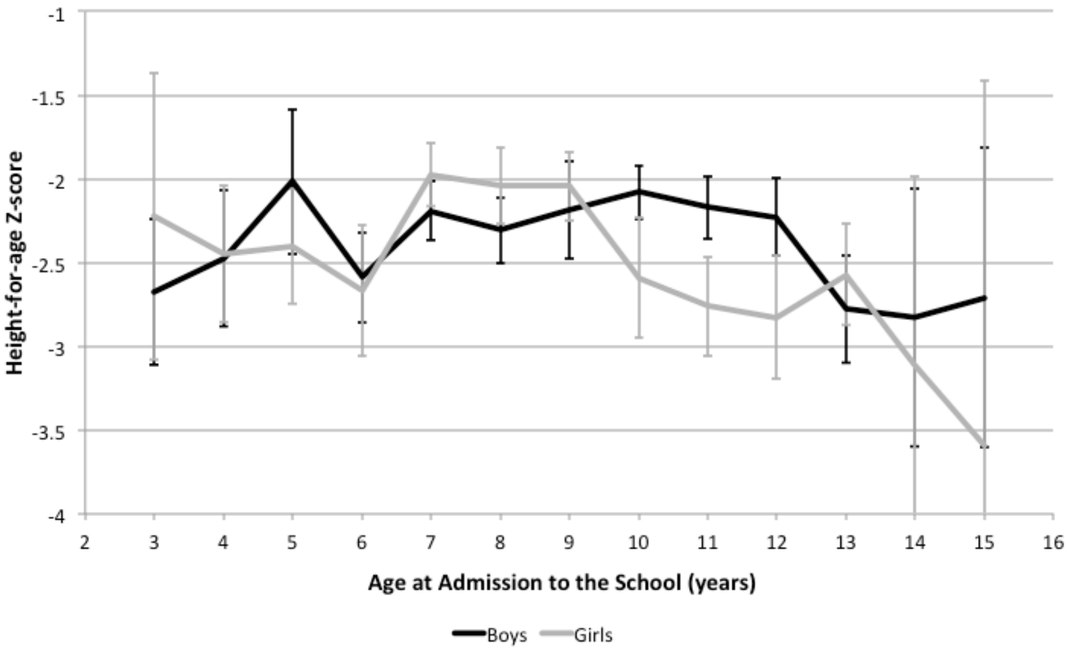
Figure 24: Predicted differences in catch-up growth between boys and girls in the Ashford School, West London School District, London, UK.



Notes: Regression coefficients from table 14 specifications 2 and 4 with 95 per cent confidence intervals. See notes for figure 23 and text for more details.

Sources: *Medical Officer's Report Book* (*n.d.*).

Figure 25: Average height-for-age Z-score at admission for one-year age groupings for children in the Ashford School.



Notes: 95% confidence intervals are included around the means. Wide confidence intervals at ages 14 and 15 are in part driven by low sample sizes, especially for girls. Children are only included when first entering the school and several outliers (almost certainly measurement errors) have been excluded.

Source: *Medical Officer's Report Book* (*n.d.*).

Tables

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 (1895, pp. 116-17); *Marcella Street Home Register* (n.d.).

Table 2: Origin of parents and father's occupations in the Bowditch sample of heights and weights of Boston school children in the 1870s.

Panel A: Origin of Parents in the Bowditch Sample

	Boys		Girls		All Children	
	n	per cent	n	per cent	n	per cent
American Origin	4,327	31.60%	3,681	33.79%	8,008	32.57%
Irish Origin	5,235	38.24%	3,623	33.25%	8,858	36.03%
American and Irish Origin	570	4.16%	418	3.84%	988	4.02%
German	752	5.49%	585	5.37%	1,337	5.44%
One or Both English	1,061	7.75%	979	8.99%	2,040	8.30%
Other Foreign or Unknown Origin	1,746	12.75%	1,609	14.77%	3,355	13.65%
Total	13,691	100.00%	10,895	100.00%	24,586	100.00%

Panel B: Father's Occupations of Children in the Bowditch Sample

	Native Fathers		Irish Fathers		All Fathers	
	n	per cent	n	per cent	n	per cent
Professional	386	9.50%	18	0.35%	404	4.40%
Mercantile	1,404	34.56%	428	8.34%	1,832	19.93%
Skilled Labour	1,655	40.73%	1,749	34.10%	3,404	37.03%
Unskilled Labour	618	15.21%	2,934	57.20%	3,552	38.64%
Total (where father's occupation known)	4,063	100.00%	5,129	100.00%	9,192	100.00%

Sources: Bowditch (1877, pp. 40-45); Bowditch (1879, pp. 38-45).

Table 3: Comparison of children entering with and without siblings into the Marcella Street Home and the Ashford School

	With Siblings		Without Siblings	
	Boys	Girls	Boys	Girls
Marcella Street Home, Boston (non-truants)				
N	130	105	64	47
Percent of Total	67.92%		32.08%	
Sex Ratio	1.24		1.36	
Percentage Male	55.32%		57.66%	
Median Age at Admission	6.74	7.91	10.74	7.38
Median Age at Discharge	8.89	9.09	11.72	10.15
Ashford School, London				
N	301	244	778	591
Percent of Total	28.47%		71.53%	
Sex Ratio	1.23		1.32	
Percentage Male	55.23%		56.83%	
Median Age at Admission	9.46	9.36	8.76	8.67
Median Age at Discharge	10.96	11.12	11.03	10.50

Notes: Truant children were admitted through a separate process and were slightly different than children entering the Marcella Street Home through the regular admissions process.

Sources: *Marcella Street Home Register* (n.d.); *Medical Officer's Report Book* (n.d.).

Table 4: Reason for discharge by gender in the Marcella Street Home.

How Discharged	Male N	Male %	Female N	Female %
Placed Out	112	55.17%	98	67.12%
Other Institution	50	24.63%	29	19.86%
Family	33	16.26%	16	10.96%
Died	4	1.97%	2	1.37%
Ran Away	2	0.99%		
Sentence Expired	2	0.99%	1	0.68%
Total	203	100%	146	100%

Sources: *Marcella Street Home Register* (n.d.).

Table 5: Correlations between length of stay in each institution and anthropometric measurements at admission.

	Overall	Girls	Boys
Marcella Street Home			
Height-for-Age Z-score	-0.084	-0.045	-0.010
Weight-for-Age Z-score	-0.208***	-0.324***	-0.181*
BMI-for-Age Z-score	0.023	-0.047	0.052
Ashford School			
Height-for-Age Z-score	0.009	0.055	-0.016
Weight-for-Age Z-score	-0.006	0.112**	-0.047
BMI-for-Age Z-score	0.065*	0.065	0.067*

Sources: *Marcella Street Home Register* (n.d.); *Medical Officer's Report Book* (n.d.).

Table 6: Descriptive statistics for anthropometric measures at admission of children in the Marcella Street Home and Ashford School as Z-scores of WHO 2006/7 references.

	Marcella Street Home, Boston		Ashford School, London	
	Boys	Girls	Boys	Girls
Height-for-age Z-Score				
mean	-1.95	-2.07	-2.26	-2.37
% over zero	4.10%	2.94%	1.96%	2.54%
Weight-for-age Z-Score				
mean	-1.02	-1.270	-1.35	-0.99
% over zero	23.81%	11.84%	5.98%	10.76%
BMI-for-age Z-Score				
mean	-0.11	0.03	-0.08	0.21
% under -2 (underweight)	2.46%	2.94%	1.59%	1.27%
% between -2 and +1 (normal)	84.83%	82.36%	87.87%	81.42%
% between +1 and +2 (overweight)	9.84%	10.78%	8.33%	15.56%
% over +2 (obese)	2.87%	3.92%	2.21%	1.75%

Sources: *Marcella Street Home Register* (n.d.); *Medical Officer's Report Book* (n.d.).

Table 7: Actual and Recommended Diet for Children in the Marcella Street Home.

Food	Actual Diet Observed November 1896 (ounces)	Recommended Diet (ounces)
Meat and fish (fresh or salted)	6.71	7
Eggs	--	0.75
Cheese	0.24	*
Milk	24.02	16
Butter and lard	0.19	1.3
Flour, cornmeal, crackers	14.13	11
Oatmeal, hominy, rice	1.44	2
Peas, beans	1.12	2*
Tapioca, sago, cornstarch	0.1	--
Sugar	1.08	3
Dried Fruits	--	0.75
Potatoes	4.8	6
Fresh vegetables	--	4
Apples	--	--
Molasses	0.5	--
Protein (grams)	95	93
Fat (grams)	55	77
Carbohydrates (grams)	380	389
Total Calories	2459	2692

Notes: *Peas, beans and cheese were combined into one category in the recommended diet.

Sources: Institutions Commissioner (1898, pp. 184-96).

Table 8: Mortality rates in the Marcella Street Home compared with child mortality rates in Boston, 1884-1890

		Annual Mortality Rate (deaths per thousand)		
Year	Number of Child Deaths (MSH)	Marcella Street Home (MSH)	Boston Children (5-10)	Boston Children (10-15)
1884-85	4	8.16		
1886	2	5.13	8.01	3.67
1887	4	10.13	9.08	4.19
1888	6	15.18	9.13	4.22
1889	3	7.23	10.66	3.42
1890	1	2.69	7.82	3.75
Average		8.04	8.94	3.85

Notes: The population of Boston aged 5-10 and 10-15 was held constant across the years at the 1890 levels. If the population were growing, this would make the early death rates underestimates of the actual mortality rates. Since we observe a slightly increasing trend for child mortality rates in Boston, we can assume that the child death rates were nearly constant.

Sources: Mortality in MSH – Board of Directors for Public Institutions (1886a, p. 177); Board of Directors for Public Institutions (1886b, p. 140); Board of Directors for Public Institutions (1887, p. 181); Board of Directors for Public Institutions (1888, p. 151); Board of Directors for Public Institutions (1889, p. 146); Commissioners of Public Institutions (1890, p. 136); Department of Public Institutions (1891, p. 104).

Monthly number of children in MSH (population at risk) – Commissioners of Public Institutions (1890, pp. 129-32); Department of Public Institutions (1891, p. 99).

Mortality and population in Boston – City Registrar (1887, p. 14); City Registrar (1888, p. 13); City Registrar (1889, p. 14); City Registrar (1890, p. 10); Secretary of the Commonwealth (1891, p. 65).

Table 9: Diet of children aged 3-7 with calorie and protein levels per day in the Ashford School.

		Quantity of Food Served per Day						
Food	Units	Sun	Mon	Tue	Wed	Thur	Fri	Sat
Breakfast:								
Cocoa	pints	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bread	oz	4	4	4	4	4	4	4
Margarine	oz	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lunch:								
Sultana Bread	oz	2	2	2	2	2	2	2
Dinner:								
Bread	oz	2	2	2	2	2	2	2
Minced Beef	oz	3						
Minced Mutton	oz			3		3		3
Soup	pints		0.75					
Baked Potatoes	oz	2				2		
Boiled Potatoes	oz			4				2
Vegetables	oz	2				2		2
Rice Pudding	oz						8	
Bread Budding	oz				8			
Supper:								
Milk	pints	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Tea	pints							
Bread	oz		4		4	4		4
Margarine	oz		0.5		0.5	0.5		0.5
Sultana Bread	oz	4		4			4	
Total Calories per Day	kcal	1641	1645	1646	1930	1698	1694	1702
Total Protein per Day	grams	59.6	57.2	66.6	51.7	63.9	49.1	65.9

Notes: Recipes for the various dishes above were used to calculate their protein and calorie content. The recipes specified the amount of raw ingredients that went into a certain amount (gallon or pound) of each dish. Calorie and protein amounts were taken from nutritiondata.self.com, which gives calorie and protein estimates for a very wide range of foods. The calories and protein of non-enriched foods were used. I tried to make reasonable assumptions when the recipes were vague for instance about the types of fresh vegetables in the soup, etc.

Sources: *Dietary Tables* (1909).

Table 10: Diet of children aged 7-14 with calorie and protein levels per day in the Ashford School.

		Quantity of Food Served per Day						
Food	Units	Sun	Mon	Tue	Wed	Thur	Fri	Sat
Breakfast:								
Cocoa	pints	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Bread	oz	5	5	5	5	5	5	5
Margarine	oz	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lunch:								
Sultana Bread	oz	2	2	2	2	2	2	2
Dinner:								
Bread	oz	3	4			3		
Baked Mutton	oz					4		
Baked Beef	oz	4						
Soup	pints		0.875					
Baked Potatoes	oz	4				4		
Boiled Potatoes	oz			8			8	
Vegetables	oz	4				4		
Meat Pie	oz			10			10	
Raisin Pudding	oz				13			13
Supper:								
Tea	pints	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Bread	oz		5		5	5		5
Margarine	oz					0.5		
Sultana Bread	oz	5		5			5	
Treacle	oz		1					
Cheese	oz				0.75			0.75
Jam or Marmolade	oz				1.5			1.5
Total Calories per Day	kcal	2027	1896	2544	2874	2070	2544	2874
Total Protein per Day	grams	71.2	66.4	82.4	56.8	76.8	82.4	56.8

Notes and Sources: see table 9.

Table 11: Children's work in the Ashford School in May 1907.

Department	Number of Chlidren Working	Approximate Total Hours of Work per Day
Boys		
Tailor	28	6
Shoemaker	20	4.5
Carpenter	9	4.5
Baker	10	8.5
Painter	5	--
Farm	23	4.5
Garden	12	4
Total Boys Working	107	
Girls		
Laundry	9	8
Staff Kitchen	6	8
Dormitories and Repairing	5	8
Infants and Babies	4	8
Staff's Apartments	4	8
Matron's Stores	1	8
Lodge	2	8
Total Girls Working	31	

Sources: Board of Management (1907, p. 58).

Table 12: Descriptive statistics of change in height-for-age, weight-for-age, and BMI-for-age Z-scores for boys and girls in the institutions

	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 general t-values above 2 were significant at the 95 per cent level.

Sources: see figure 18.

Table 13: 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	0.365**	1.177***	-0.502	0.284
	(-0.71)	(2.35)	(10.43)	(-0.68)	(0.42)
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)
Father Dead (1=dead)	0.146	0.130	0.117	0.093	0.105
	(1.64)	(1.41)	(1.19)	(1.07)	(1.16)
Mother Dead (1=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)
Truancy Dummy	-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				
	(-1.26)				
Boys Age 3 Dummy		-0.645***	-0.315***	.	.
		(-9.33)	(-7.30)	.	.
Boys Age 4 Dummy		0.317	0.475	-0.367	-0.248
		(0.88)	(0.99)	(-0.83)	(-0.41)
Boys Age 5 Dummy		-0.630	-0.266	0.079	-0.091
		(-0.97)	(-0.26)	(0.30)	(-0.17)
Boys Age 6 Dummy		-0.106	-0.443	-0.230	-0.107
		(-0.65)	(-1.50)	(-1.53)	(-0.41)
Boys Age 7 Dummy		-0.406**	-0.364*	-0.719**	-0.870**
		(-1.97)	(-1.67)	(-2.37)	(-2.04)
Boys Age 8 Dummy		0.203	0.148	0.167	0.142
		(1.25)	(0.57)	(0.88)	(0.50)
Boys Age 9 Dummy		-0.044	-0.013	0.044	0.186
		(-0.30)	(-0.06)	(0.23)	(0.88)
Boys Age 10 Dummy		-0.357	-0.486	0.028	-0.055
		(-1.20)	(-1.15)	(0.23)	(-0.35)
Boys Age 11 Dummy		0.194	0.145	0.550	0.648
		(1.36)	(0.75)	(1.23)	(1.54)
Boys Age 12 Dummy		0.283	0.312	-0.201	-0.334*
		(0.96)	(1.05)	(-1.43)	(-1.87)
Boys Age 13 Dummy		-0.337*	-0.489**	-0.692***	-0.732***
		(-1.93)	(-2.22)	(-2.80)	(-2.89)
Boys Age 14 Dummy		-0.985***	-0.967***	-0.665***	-0.780***
		(-5.03)	(-3.87)	(-3.72)	(-4.68)
Boys Age 15 Dummy		-0.452**	-0.434***	-0.542**	-0.321*
		(-2.18)	(-2.71)	(-2.28)	(-1.93)
Unreported Dummies:					
Discharge Age Dummies		X	X		
Middle Age in Institution Dummies				X	X
R-square	0.30	0.49	0.26	0.47	0.27
F-statistic	6.73				

Notes: see table 14.

Sources: Marcella Street Home Register (*n.d.*).

Table 14: 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
Constant	-0.036	-0.269***	-0.214***	0.537***	0.701***
	(-0.73)	(-5.85)	(-4.88)	(5.30)	(19.83)
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***				
	(-3.57)				
Boys Age 2 Dummy		.	.	-0.808***	.
		.	.	(-8.03)	.
Boys Age 3 Dummy		0.062	0.103	-0.053	-0.020
		(0.22)	(0.32)	(-0.23)	(-0.07)
Boys Age 4 Dummy		-0.795***	-0.708***	-0.567	-0.472
		(-10.82)	(-8.52)	(-1.46)	(-1.18)
Boys Age 5 Dummy		-0.204	-0.173	0.007	0.019
		(-1.43)	(-1.25)	(0.07)	(0.20)
Boys Age 6 Dummy		-0.076	-0.095	-0.039	-0.073
		(-0.54)	(-0.72)	(-0.38)	(-0.72)
Boys Age 7 Dummy		-0.043	-0.080	-0.038	-0.065
		(-0.71)	(-1.28)	(-0.53)	(-0.88)
Boys Age 8 Dummy		-0.062	-0.080	-0.039	-0.038
		(-0.56)	(-0.72)	(-0.41)	(-0.40)
Boys Age 9 Dummy		0.076	0.098	0.099	0.100
		(1.13)	(1.37)	(1.38)	(1.36)
Boys Age 10 Dummy		0.036	0.022	-0.016	-0.040
		(0.47)	(0.29)	(-0.24)	(-0.63)
Boys Age 11 Dummy		0.069	0.025	-0.070	-0.098*
		(1.18)	(0.48)	(-1.31)	(-1.81)
Boys Age 12 Dummy		-0.192***	-0.227***	-0.426***	-0.470***
		(-2.67)	(-3.13)	(-4.87)	(-5.50)
Boys Age 13 Dummy		-0.465***	-0.474***	-0.402***	-0.407***
		(-5.25)	(-5.25)	(-4.82)	(-4.80)
Boys Age 14 Dummy		-0.388***	-0.397***	-0.348	-0.328
		(-4.00)	(-4.01)	(-0.94)	(-0.85)
Boys Age 15 Dummy		-0.606**	-0.620**	-1.093***	-1.184***
		(-1.98)	(-1.97)	(-3.13)	(-3.28)
Unreported Dummies:					
Discharge Age Dummies		X	X		
Middle Age in Institution Dummies				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**				

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

Sources: Medical Officer's Report Book (*n.d.*).

Table A1: Change in weight-for-age Z-score regressions for children under 10 in 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	73	73	81	73	81
Constant	-0.062	0.181	1.087***	0.157	0.943***
	(-0.36)	(0.80)	(4.45)	(0.84)	(5.14)
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)
Father Dead (1=dead)	-0.329	-0.642*	-0.259	-0.657**	-0.432
	(-1.11)	(-1.80)	(-0.41)	(-2.50)	(-1.00)
Mother Dead (1=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)
Truancy Dummy	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				
	(-0.58)				
Boys Age 3 Dummy		0.544	-0.433	.	-0.410
		(1.39)	(-0.91)	.	(-1.43)
Boys Age 4 Dummy		0.554	0.516	0.430	0.327
		(1.45)	(1.23)	(1.31)	(0.91)
Boys Age 5 Dummy		0.373	0.226	-0.008	0.222
		(1.67)	(0.59)	(-0.04)	(0.67)
Boys Age 6 Dummy		-0.214	-0.200	-0.196	-0.349
		(-0.62)	(-0.47)	(-0.53)	(-0.68)
Boys Age 7 Dummy		-0.569*	-0.620*	-0.773***	-0.665***
		(-1.82)	(-1.73)	(-3.61)	(-2.67)
Boys Age 8 Dummy		0.184	-0.136	0.046	-0.185
		(0.66)	(-0.41)	(0.23)	(-0.78)
Boys Age 9 Dummy		-0.084	-0.120	-0.115	-0.171
		(-0.39)	(-0.52)	(-0.36)	(-0.54)
Boys Age 10 Dummy		-1.399***	-0.510		
		(-3.23)	(-0.76)		
Unreported Dummies:					
Discharge Age Dummies		X	X		
Middle Age in Institution Dummies				X	X
R-square	0.40	0.57	0.30	0.53	0.39
F-statistic	4.52				

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

Sources: *Marcella Street Home Register* (*n.d.*).

Table A2: Change in weight-for-age Z-score regressions for children under 10 in 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
Constant	0.214***	0.170**	0.130*	0.148	0.315***
	(3.37)	(2.06)	(1.72)	(1.55)	(5.50)
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)	
Weight 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				
	(1.09)				
Boys Age 2 Dummy		.	0.562***		
		.	(7.94)		
Boys Age 3 Dummy		-0.701*	-0.794**	-0.888**	-0.966**
		(-1.72)	(-2.08)	(-2.07)	(-2.38)
Boys Age 4 Dummy		-0.241	-0.441	-0.228	-0.408
		(-0.44)	(-0.96)	(-0.72)	(-1.54)
Boys Age 5 Dummy		-0.133	-0.242	-0.203	-0.280**
		(-0.90)	(-1.62)	(-1.57)	(-2.18)
Boys Age 6 Dummy		-0.049	0.009	0.247	0.340*
		(-0.26)	(0.05)	(1.39)	(1.85)
Boys Age 7 Dummy		0.069	0.177*	0.024	0.111
		(0.69)	(1.74)	(0.28)	(1.22)
Boys Age 8 Dummy		0.024	0.106	0.135	0.209**
		(0.27)	(1.08)	(1.62)	(2.39)
Boys Age 9 Dummy		0.156**	0.205***	0.101	0.136**
		(2.29)	(2.85)	(1.60)	(2.01)
Boys Age 10 Dummy		0.339**	0.448**		
		(2.04)	(2.40)		
Unreported Dummies:					
Discharge Age Dummies		X	X		
Middle Age in Institution Dummies				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				

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

Sources: Medical Officer's Report Book (*n.d.*).

Table A3: Change in BMI-for-age Z-score regressions for children under 10 in 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	246	246	246	246	246
Constant	0.412***	1.329***	1.565***	1.343***	1.558***
	(3.01)	(6.96)	(13.33)	(7.75)	(14.18)
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)
Father Dead (1=dead)	0.013	0.040	0.050	0.021	0.014
	(0.12)	(0.37)	(0.39)	(0.18)	(0.11)
Mother Dead (1=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)
Truancy Dummy	-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*				
	(-1.81)				
Boys Age 3 Dummy		1.178***	0.609***		
		(4.83)	(2.70)		
Boys Age 4 Dummy		0.602	0.469	0.887*	0.682
		(1.47)	(0.83)	(1.96)	(1.13)
Boys Age 5 Dummy		0.993***	0.487	0.295	0.462
		(2.69)	(0.85)	(1.35)	(1.51)
Boys Age 6 Dummy		0.030	0.149	0.141	-0.075
		(0.06)	(0.23)	(0.26)	(-0.10)
Boys Age 7 Dummy		-0.266	-0.402	-0.353	-0.290
		(-0.74)	(-0.92)	(-1.30)	(-0.89)
Boys Age 8 Dummy		-0.157	-0.232	-0.331	-0.368
		(-0.38)	(-0.45)	(-1.41)	(-1.24)
Boys Age 9 Dummy		-0.196	-0.197	-0.285	-0.378
		(-0.84)	(-0.87)	(-1.20)	(-1.46)
Boys Age 10 Dummy		-0.014	0.113	0.108	0.230
		(-0.07)	(0.53)	(0.65)	(1.18)
Boys Age 11 Dummy		-0.036	0.098	-0.432	-0.599
		(-0.16)	(0.33)	(-0.90)	(-1.45)
Boys Age 12 Dummy		-0.316	-0.330	-0.370	-0.167
		(-1.01)	(-1.09)	(-1.64)	(-0.66)
Boys Age 13 Dummy		-0.568**	-0.470	-0.127	-0.164
		(-2.28)	(-1.62)	(-0.47)	(-0.59)
Boys Age 14 Dummy		0.227	0.289	-0.678***	-0.358
		(0.56)	(0.70)	(-2.84)	(-1.57)
Boys Age 15 Dummy		-0.536	-0.528	-0.599	-0.937***
		(-1.58)	(-1.48)	(-1.65)	(-3.11)
Unreported Dummies:					
Discharge Age Dummies		X	X		
Middle Age in Institution Dummies				X	X
R-square	0.23	0.38	0.17	0.34	0.15
F-statistic	6.54				

Notes and Sources: See table A1.

Table A4: Change in BMI-for-age Z-score regressions for children under 10 in 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
Constant	0.371***	-0.259*	1.161***	1.342***	1.168***
	(6.00)	(-1.80)	(16.14)	(20.97)	(16.12)
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				
	(0.48)				
Boys Age 3 Dummy		-0.873	-1.050*	-1.012*	-1.150**
		(-1.39)	(-1.70)	(-1.68)	(-2.06)
Boys Age 4 Dummy		0.140	-0.384	0.189	-0.325
		(0.33)	(-1.36)	(0.68)	(-1.52)
Boys Age 5 Dummy		0.005	-0.212	-0.315	-0.461**
		(0.03)	(-1.22)	(-1.53)	(-2.44)
Boys Age 6 Dummy		-0.014	0.088	0.352	0.498*
		(-0.05)	(0.31)	(1.33)	(1.86)
Boys Age 7 Dummy		0.140	0.281**	0.091	0.214*
		(1.11)	(2.03)	(0.76)	(1.69)
Boys Age 8 Dummy		0.092	0.185	0.169*	0.221**
		(0.79)	(1.46)	(1.84)	(2.18)
Boys Age 9 Dummy		0.155*	0.131	0.241**	0.246**
		(1.72)	(1.24)	(2.29)	(2.06)
Boys Age 10 Dummy		0.158	0.251*	-0.065	0.044
		(1.34)	(1.78)	(-0.59)	(0.31)
Boys Age 11 Dummy		-0.019	0.084	-0.077	0.013
		(-0.25)	(0.96)	(-0.80)	(0.14)
Boys Age 12 Dummy		0.006	0.105	-0.176	-0.064
		(0.04)	(0.69)	(-1.04)	(-0.36)
Boys Age 13 Dummy		-0.270*	-0.210	-0.143	-0.099
		(-1.75)	(-1.29)	(-1.11)	(-0.74)
Boys Age 14 Dummy		-0.432**	-0.373**	0.276	0.213
		(-2.50)	(-2.21)	(0.71)	(0.62)
Boys Age 15 Dummy		1.334***	1.417***	0.019	-0.241
		(3.60)	(2.82)	(0.08)	(-1.05)
Unreported Dummies:					
Discharge Age Dummies		X	X		
Middle Age in Institution Dummies				X	X
Parish/Poor Law Union Dummies	X	X	X	X	X
R-square	0.26	0.34	0.22	0.32	0.21
F-statistic	20.96				

Notes and Sources: See table A2.