Smallpox really did reduce height: a reply to Razzell

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Peter Razzell believes that we have misunderstood the nature of his criticism and are correspondingly dismissive of it. Nothing could be further from the truth. We share every professional historian's concern for the integrity of the data. Indeed in other work that we have done, we have 'left our computers' and have both proven keen archival historians.[1]

Razzell argues that the quality of smallpox recording in the Marine Society data set is so poor that 'the impact of smallpox on average height cannot be settled by analysis of the Marine Society data set'.[2] We believe that this grossly overstates the problems of the records, and is based on a careless reading of the original records on his part. Furthermore, insofar as his claim that some of the boys who are recorded as escaping smallpox had in fact suffered the disease, the direction of bias strengthens rather than weakens the statistical evidence that smallpox reduced height.

At the heart of the reliability issue is the method of recording whether a boy had suffered smallpox. The Marine Society Registrars recorded that a boy had had smallpox by placing a *p* in the column labelled 'spox', leaving it blank otherwise.

Similarly they recorded a person as literate by placing an *r* in the reading column and a *w* in the writing column, leaving them blank otherwise. The computerised data set likewise contains a mark where the original records have one, and a blank otherwise. Interpreting a *p* in the spox column is thus straightforward: the registrar clearly believed the boy to have had smallpox. The adequacy of smallpox registration thus turns on our interpretation of a blank in the smallpox column. If the registrar was conscientious, a blank in the spox column would indicate that the registrar believed that the boy had not had smallpox. If the registrar was incompetent or negligent, a blank would indicate that he failed either to ask the question or to record the answer. In claiming 'complete inadequacy of smallpox registration' Razzell is arguing that the registrars frequently failed to fill in their registers properly.

He bases this conclusion on a comparison of the columns for literacy and smallpox. He argues that if the columns for reading and writing as well as smallpox are blank, it is more likely that the returning officer was negligent. Although no one can doubt that some of the thousands of boys entering the society were illiterate as well as had escaped smallpox, it would indeed be cause for concern were there to be long series of boys for whom there were no marks in any of the three columns. Razzell then goes on to look at how frequently those boys recorded as escaping smallpox were also recorded as being illiterate. It is this literacy test that he claims 'reveals the complete inadequacy of smallpox registration.' But his investigation is seriously flawed. He claims, for example, that in the years 1777-1778 there are 151 boys listed as having escaped smallpox.[3] This is simply not correct: the original records show that there were 197 boys in those years who had not had smallpox.[4] More importantly Razzell claims that in the 71-year period in which the Marine Society collected data on smallpox there are only 29 boys recorded as being literate and escaping smallpox.[5] In fact the original records show that there are more than this number in the first dozen years alone, and more than three times this number in total.[6] Razzell claims to have 'provided the new economic history with an invaluable lesson – there is no substitute

for the scrupulous study of original source material'; given his archival errors we suggest that this message needs to be learned by old as well as new economic historians.

As new economic historians we make no claim that the data is perfect. No doubt the original records contains both honest error and pieces of poor recording. One of the most powerful features of statistics is that it does not demand perfect data to give meaningful results. In this case, in fact, to the extent that Razzell is right that some of the boys recorded as having escaped smallpox had in fact suffered the disease, it strengthens, not weakens, our results. This is seen most clearly through a numerical example.

We found that those boys with a *p* in the smallpox column were statistically shorter than those boys who did not have a *p* in that column. That much is not in dispute. Let us imagine – for simplicity – that, correcting for age and other factors, we found that the height of the former group was 54 inches and that the height of the latter group was 55 inches. If the records are perfectly accurate it follows that smallpox reduced heights, and did so by one inch. Imagine now that Razzell's criticisms are well founded, and that half of the boys without a *p* in the smallpox column had in fact suffered smallpox but that this was not recorded by hasty registrars. What then would we know? We would still know that the height of those with smallpox was 54 inches – again, that much is not in dispute. But we would also know that the average height of a group made up half of boys with smallpox and half of boys without smallpox was 55 inches. Since we know that the half with smallpox averaged 54 inches in height, it follows that the half without smallpox must have been 56 inches tall to yield an average of 55 inches for the mixed group. In this case those who suffered smallpox were two inches – rather than one inch – shorter than those who had not suffered the disease. In short, if Razzell is right that some of the boys recorded as escaping the disease had in fact suffered it, not only does our conclusion that smallpox reduced

height remain correct, but it means that the true effect of smallpox on height would be even larger than we originally argued.

Let us turn now to the data itself. Razzell has stated that 'genuine cases of "no smallpox" can possibly be recognised by their occurrence in individual entries with information on reading or writing'.[7] In effect, if a boy has a mark in the literacy column we can be more certain that his recording officer was conscientious, and, as such, more certain that his smallpox information is reliable. Although we think Razzell is pessimistic about the registrars' diligence, we are happy to use the literate sub-sample of boys to test whether smallpox did indeed reduce height.

In order to show not just that smallpox reduced height, but that following Razzell's recommendations strengthens rather than weakens our results, we test for the effect of smallpox on both the whole sample and on that sub-group recorded as literate. We use data beginning with the first person to be recorded as suffering from smallpox and ending in 1841, the last year in which we see entries in the smallpox column. Since the minimum height standard changed over this period, we also include a dummy variable for each of the sub-periods.[8] These capture not only the changes in the Marine Society's minimum height standards, but also more general changes in living standards over time.

Regression about here.

The results are clear and unambiguous. In both regressions smallpox is shown to reduce height. In both cases the co-efficient on smallpox is significant at the one per cent level. Those who are more optimistic about the quality of the recording process will favour using the whole sample. More sceptical researchers will prefer to look only at those recorded as being literate. In either case they will conclude that smallpox did indeed reduce heights.

As basic logic would lead us to expect, following Razzell's advice to look only at a more restrictive set of data (about which we can be more confident) strengthens rather than weakens our conclusion. Our estimate of the height reducing effect of smallpox rises from a quarter of an inch to three quarters of an inch. The reasoning is exactly as for the earlier numerical example. It is worth noting that the regression performs well more generally. Those who are older are taller, as are those admitted when there was a higher minimum height standard. With the exception of literacy, every variable is significant at the one per cent level.

What then should we conclude? First, we can say, more clearly than before, that smallpox reduced heights. Second, the difference between the estimates of the effect of smallpox on height in the two regressions do indeed indicate that there were periods in which the registrars were less conscientious than historians would like them to have been. Third, as we have shown, the effect of such errors does not invalidate the work of new economic historians using the data set; instead it strengthens their results.

Rigorous archival and statistical examination confirms that one of the most infectious and deadly diseases not only left many survivors scarred for life, but also stunted their growth. This should not surprise us. We know from contemporary medical research that measles has substantial effects on the nutritional status of children in the third world.[9] Since smallpox was, by all accounts, a far more virulent and life-threatening disease than measles, to conclude that smallpox did not reduce heights would pose a medical puzzle.

Such a result would also pose a problem for anthropometric history. It has as its cornerstone the claim that attained height reflects an individual's cumulative nutritional status during childhood – including the effect of disease. Were we to find

that the ‘most terrible of all the ministers of death’ did not affect the attained heights of those who survived, then we would be forced to question the very basis of anthropometric history.[10] We have been able to go further than showing simply that smallpox reduced heights, and have been able to estimate the height loss at a little under 1 inch. As we suggested in our original article, we see this finding as furthering anthropometric history by beginning to answer Crafts’ objection that anthropometric historians need to ‘pin down links between the various aspects of the quality of life and height.’[11] The movement from endemic smallpox to no smallpox would have raised average attained heights by a little under one inch. Once we know how attained heights alter with changes in working hours, the age at which children start work, nutritional intake, over-crowding, and so on, we will be better able to interpret the changing heights of individual populations over time, and the height differences between populations. Then we will be better placed to do what all economic and social historians, new and old, seek to do: to understand and explain the standard of living in different societies, at different times.

Table 1. *The determinants of height*

	1	*2*
Smallpox	-0.25	-0.75
	(-3.0)	(-3.2)
Age years	1.68	1.67
	(162.0)	(125.9)
Read	0.07	
	(1.7)	
Write	0.43	0.44
	(11.3)	(11.3)
1786-91 (54 inches)	0.61	0.67
	(12.2)	(10.3)
1792-97 (52 inches)	0.22	0.26
	(5.0)	(4.4)
1798-1808 (54 or 52 inches)	-0.55	-0.48
	(-12.9)	(-8.7)
1809-11 (50 or 51 inches)	-1.40	-1.30
	(-24.5)	(-17.3)
1812-13 (51 inches)	-1.29	-1.26
	(-19.4)	(-15.4)
1814-17 (54 inches)	0.43	0.44
	(4.9)	(4.1)
1818-20 (55 inches)	1.87	1.90
	(14.5)	(12.8)
1821-23 (56 inches)	2.73	2.74
	(24.6)	(22.6)
1824-41 (57 inches)	3.35	3.29
	(54.4)	(47.9)
Intercept	30.40	31.10
	(180.9)	(102.5)
Adj R^2	0.65	0.65
S.E.	2.18	2.20
F	3371.5	2348.5
N	23971	15173
of which, with smallpox	23206	15085
without smallpox	765	88

Notes:
Regression one includes all boys, regression two is limited to those recorded as being literate.
t-statistics in parentheses
The estimation technique is OLS, estimated using Stata 6
The omitted sub-period is 1770-1785 (minimum height standard, 51")

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[1] Among other work, Leunig has just collected 12500 pay roll records from the archives of a New England cotton mill, and Voth has assembled and analysed some 8,000 court records from Old Bailey Sessions Papers as well as hundreds of Northern Assize depositions. Voth, 'Time Use'.
[2] Razzell, 'Brief comment', last para.
[3] Razzell, 'Brief comment', p. 2, para 2.
[4] We have supplied the Editor with the Marine Society reference numbers for each of the individuals, and we are happy to supply the list to interested readers.
[5] Razzell, 'Did smallpox reduce height?', p. 357
[6] Again, we have supplied the Editor with the Marine Society reference numbers, and we are happy to supply the list to any interested reader.
[7] Razzell, 'Did Smallpox?'
[8] The sub-periods are listed in Floud et al. *Height* p. 164
[9] Krishnamurthy and Ananthraraman, 'Measles', Reddy 'Interaction'
[10] Macauley, *History of England*, II, p. 498
[11] Crafts, 'Cliometrics', p. 189