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# BIOSOCIAL CORRELATES OF STATURE IN A BRITISH NATIONAL COHORT

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**Summary**. Analyses of height variation using the 1970 UK national cohort study (12,508 children at age 10 and 5470 at age 16) found clear evidence that children of higher socioeconomic status (as measured by social class, crowding, tenure, type of accommodation, income and receipt of government financial assistance) were on average taller than children of lower socioeconomic status but there was little or no difference in average stature between children living in urban or rural areas. Significant differences in height remained for most of the variables after removing the effects of father's social class suggesting that reliance on social class *per se* to explain height variation is inadvisable.

## Introduction

A large number of biosocial variables have been shown to associate with the physical development of children including social class, crowding in the home, geographical region of the country, type of accommodation and receipt of government financial benefit (Tanner, 1962; Topp *et al.*, 1970; Goldstein, 1971; Fogelman, 1983; Mascie-Taylor & Boldsen, 1985; Stinson, 2000). In general poorer conditions (lower socioeconomic status) or increased family size are associated with a reduction in average stature. For social class a downward trend in mean height from social class I (professional) to class V (unskilled manual worker) has usually been observed (Lasker & Mascie-Taylor, 1989, 1996) but studies of Swedish urban schoolchildren found no social class differences (Lindgren, 1976; Lindgren & Cernerud, 1992). Terrell and Mascie-Taylor (1991) analysed the height variation of 16-year-old members of the British National Child Development Study (children born in 1958) and found significant associations with a number of variables including social class, crowding status, tenure, sex of the child and type of accommodation.

The present study extends the analyses of biosocial correlates with height to examining the 1970 British cohort study. The main objectives were to test whether children living in more disadvantaged homes had, on average, lower heights than children living in better homes and whether such findings are consistent at different ages of the child (10 and 16 years of age).

**Table 1.** Mean and standard deviation of height for males and females at ages 10 and 16

| Sex | Age 10 | | | Age 16 | | |
|---|---|---|---|---|---|---|
| | *n* | Mean | SD | *n* | Mean | SD |
| Male | 6426 | 138·72 | 6·41 | 2652 | 173·40 | 8·57 |
| Female | 6082 | 138·41 | 6·70 | 2818 | 162·42 | 7·00 |

## Methods

The data came from the 1970 British National Cohort Study, which is a longitudinal survey of children and their families living in the United Kingdom (England, Wales, Scotland and Northern Ireland). All children born in the first week of April 1970 were enrolled in the study and they and their families were re-examined when the child was 5, 10 and 16 years of age. Any child born in that week who entered the country after April 1970 was also included in the study. Height was measured as part of a medical examination of each child and just over 12,000 children were measured in 1980. However, in the 1986 follow-up there were a number of logistical constraints and heights were only obtained on 5500 individuals.

Of the twelve biosocial variables included here, eleven were defined identically at both ages; the only variable that varied between follow-ups was income. In 1980 six weekly-income bands were defined (see Table 2) rising in £50 increments, with a final band of £250 and above. In the 1986 study a 7-band scale was used with a final band of £300/week and above. Crowding (measured as the number of permanent residents/number of rooms) was organized into four categories of <0·5 persons, 0·5–0·74, 0·75–0·99 and 1 or more persons per room. Number of children in the family was determined (range 1 to 4 or more children). Accommodation was classified into two groups of either owned or rented while the type of accommodation was defined as either house/bungalow or flat/mobile home and the location as either rural or urban. At the time of each follow-up details of the employment status (employed or not employed), supplementary benefits received (yes or no), and whether the child received free school meals (yes or no) was obtained. The number of family moves since birth was determined (range one to three moves or more). The mother and father were placed into one of five social class groupings according to the Registrar General's Classification of Occupations based on their occupation in 1980 and 1986. The five categories refer to professional (I), managerial (II), skilled non-manual and manual (III), semi-skilled (IV) and unskilled (V).

Because there were significant differences in mean heights of males and females, but no significant sex and biosocial variable interactions, hierarchical analyses of variance were used in which the effect of sex was removed before testing for the significance of each biosocial variable in turn. In the second set of analyses the effects of both sex and father's social class were removed before testing for the significance of each remaining biosocial variable. The analyses place one category group within

**Table 2.** Summary of associations between biosocial variables and height at age 10 and 16

| | Height at 10 years of age | | | | Height at 16 years of age | | | |
|---|---|---|---|---|---|---|---|---|
| Variable name | After removing the sex effect | *p* | After removing sex and father's social class effects | *p* | After removing the sex effect | *p* | After removing sex and father's social class effects | *p* |
| Crowding | | <0·001 | | <0·001 | | <0·001 | | =0·008 |
| <0·5 | +2·55 | | +1·80 | | +3·78 | | +1·86 | |
| 0·5–0·74 | +1·77 | | +1·26 | | +2·63 | | +1·14 | |
| 0·75–0·99 | +1·17 | | +0·90 | | +1·66 | | +0·26 | |
| 1·0+/room | 0 | | 0 | | 0 | | 0 | |
| Accommodation | | <0·001 | | <0·001 | | ns | | ns |
| Own | +1·50 | | +1·15 | | +1·18 | | +0·90 | |
| Rented | 0 | | 0 | | 0 | | 0 | |
| Type of housing | | <0·001 | | <0·001 | | ns | | ns |
| House/bungalow | +1·18 | | +0·85 | | +0·73 | | +0·15 | |
| Flat/mobile home | 0 | | 0 | | 0 | | 0 | |
| Employment | | <0·001 | | <0·001 | | ns | | ns |
| Employed | +2·58 | | +2·02 | | +1·85 | | 0·87 | |
| Unemployed | 0 | | 0 | | 0 | | 0 | |
| Family moves since birth | | =0·047 | | =0·009 | | ns | | ns |
| None | +0·22 | | +0·45 | | +0·74 | | −0·63 | |
| 1 move | −0·05 | | +0·10 | | +1·13 | | −0·12 | |
| 2 moves | −0·26 | | −0·13 | | +1·23 | | −0·35 | |
| 3+ moves | 0 | | 0 | | 0 | | 0 | |

**Table 2.** *Continued*

| | Height at 10 years of age | | | | Height at 16 years of age | | | |
|---|---|---|---|---|---|---|---|---|
| Variable name | After removing the sex effect | *p* | After removing sex and father's social class effects | *p* | After removing the sex effect | *p* | After removing sex and father's social class effects | *p* |
| Residence | | <0·001 | | <0·001 | | ns | | ns |
| Urban | −0·93 | | −0·69 | | +0·07 | | +0·04 | |
| Rural | 0 | | 0 | | 0 | | 0 | |
| Supplementary benefits | | <0·001 | | <0·001 | | <0·001 | | =0·02 |
| No | +1·76 | | +1·81 | | +1·83 | | +1·22 | |
| Yes | 0 | | 0 | | 0 | | 0 | |
| Free school meals | | <0·001 | | <0·001 | | <0·001 | | =0·001 |
| No | +1·85 | | +2·00 | | +3·30 | | +2·20 | |
| Yes | 0 | | 0 | | 0 | | 0 | |
| Social class of father | | <0·001 | | | | <0·001 | | |
| I | +2·56 | | | | +2·93 | | | |
| II | +2·55 | | | | +3·25 | | | |
| III | +1·12 | | | | +1·71 | | | |
| IV | +0·79 | | | | +1·05 | | | |
| V | 0 | | | | 0 | | | |
| Social class of mother | | <0·001 | | <0·001 | | <0·001 | | =0·007 |
| I | +3·32 | | +2·76 | | +6·28 | | +2·74 | |
| II | +1·69 | | +1·14 | | +2·44 | | +1·47 | |
| III | +1·14 | | +0·80 | | +2·19 | | +1·26 | |
| IV | +0·02 | | −0·08 | | +0·50 | | +0·17 | |
| V | 0 | | 0 | | 0 | | 0 | |

**Table 2.** *Continued*

| Variable name | Height at 10 years of age: After removing the sex effect | p | Height at 10 years of age: After removing sex and father's social class effects | p | Height at 16 years of age: After removing the sex effect | p | Height at 16 years of age: After removing sex and father's social class effects | p |
|---|---|---|---|---|---|---|---|---|
| Income per week (£) | | =0·039 | | <0·001 | | <0·001 | | <0·001 |
| <50 | −3·05 | | −2·89 | | −4·08 | | −1·53 | |
| 50–99 | −2·52 | | −1·89 | | −2·92 | | −1·80 | |
| 100–149 | −1·62 | | −1·00 | | −3·03 | | −1·57 | |
| 150–199 | −0·97 | | −0·56 | | −2·42 | | −1·00 | |
| 200–249 | −0·62 | | −0·51 | | −1·53 | | −0·79 | |
| 250+ (10 years) | 0 | | 0 | | | | | |
| 250–300 (16 years) | | | | | −1·29 | | −0·54 | |
| 300+ (16 years) | | | | | 0 | | 0 | |
| Family size | | <0·001 | | <0·001 | | +0·006 | | =0·03 |
| 1 | +2·33 | | +2·12 | | +0·97 | | +0·21 | |
| 2 | +1·80 | | +1·52 | | +2·06 | | +1·06 | |
| 3 | +0·83 | | +0·64 | | +1·27 | | +0·16 | |
| 4+ | 0 | | 0 | | 0 | | | |

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each variable as a reference value which is set to zero and in these analyses crowding status of 1·0 or more, rented accommodation, flat/mobile home, unemployed, three or more family moves, living in a rural area, no supplementary benefits, no free school meals, social class V, income of £250/week or more (aged 10) and £300/week or more (aged 16) were used.

## Results and discussion

Table 1 presents a breakdown of the sample size, and mean and standard deviation by sex at ages 10 and l6. Boys were, on average, about one-third of a centimetre taller at age 10 ($p<0{\cdot}01$) but by 16 years of age the height difference had increased to just under 11 cm ($p<<0{\cdot}001$). The results of the hierarchical analyses of variance (Table 2) show that overall there was high consistency between the results at age 10 and 16 although the magnitude of the effects varied, as did the significance of the findings; more results were significant at 10 than 16.

To summarize, children who were living in more disadvantageous conditions, i.e. greater crowding, with more sibs, worse accommodation, receiving free school meals and supplementary benefits, had, on average, lower statures than better off children. For crowding there was a trend of decreasing stature from less to more crowded conditions, and this was apparent at both 10 and 16 years. A similar trend was observed with social class with means decreasing from I to V. Income effects were more significant at 16 years of age while the number of family moves was barely significant at age 10 and was not significant at all at age 16.

In order to gain further insight into the relationship between height and each variable, a second group of hierarchical analyses of variance were conducted in which the sex effect and the father's social class effects were removed initially before testing for each variable in turn. This approach was used since it is widely known that many of the variables are associated with social class, e.g. more crowding, is found in lower social classes. The results of the second tranche of analyses are also presented in Table 2.

In the main the magnitude of the effects and their significance declined after removing the effects of father's social class as well as sex. The trend of a decrease in height with increased crowding was maintained at both 10 and 16 years. Accommodation, type of housing, employment and residence were all insignificant at 16 years and significant at 10 years although with smaller differences than with the sex effect only removed. The relationship with number of family moves remained insignificant at 16 while at 10 the differences between none and 3+ increased. At 10, urban children were significantly shorter, on average, than rural children but at 16 the difference had disappeared. The effect of supplementary feeding and free school meals remained significant at both 10 and 16 with slightly elevated differences in 10 year olds. Mother's social class continued to be significant at 10 and 16 with a general downward trend from I to V. Although children of families in the highest income bracket had the highest mean stature, only in 10 year olds was there evidence of a downward trend of height with decreasing income. Having more sibs was associated with reduced height in 10 year olds but there was no obvious trend in 16 year olds.

The analyses reveal that a large number of biosocial variables are associated with height in this cohort of children and that reliance on social class of either the male or female parent to 'explain' height variability is insufficient. Indeed growth seems to operate within the context of a large biosocial environment. Furthermore when the effect of the father's social class is removed initially many of the other variables remain highly significant providing further support to the notion that social class *per se* needs to be enlarged to the social class complex and beyond. The analyses demonstrate that disadvantage is associated with poorer growth and lower than average statures apparent by age 10. Simple reductionism from the complexity of the environment to a few variables is inadvisable (Lasker & Mascie-Taylor, 1989; Mascie-Taylor, 1990, 1991, 1998) and it is very likely that some important information on some key variables was not collected as part of these cohort studies. Finally although other associations between biosocial variables and stature have been found, the causal nature of such analyses remains unclear.

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