Human Assortative Mating for Height: Non-Linearity and Heteroscedasticity

By I. C. McManus[1] and C. G. N. Mascie-Taylor[2]

> "I see nothing to admire so much in those diminitive women; they look silly by the side o' the men - out o' proportion. When I chose my wife, I chose her the right size - neither too little nor too big."
>
> George Eliot, The Mill on the Floss

ABSTRACT

Positive assortative mating for stature is widely reported to occur in most Western societies. In this paper we analysed data collected by the National Child Development Study as part of their longitudinal survey of British children and their families. The reported heights of 12,994 husband and wife pairs produced a simple correlation of +0.258. However, further analyses indicated that the relationship between husband's height and wife's height is non-linear for the complete range of statures, indeed in the case of women at the upper extreme (> 1.80 meters) there is evidence of negative assortative mating.

Assortative mating, the tendency of like to marry like, is common in most Western human populations for a variety of phenotypic characters (Roberts, 1977) many of which, such as intelligence and height, are of interest in that both genetic and environmental facters are probably important in their determination. Genetic models of continuous characters usually account for assortative mating by including a single component which explains a proportion of the total population variance. (Cavalli-Sforza and Bodmer, 1971; Mather and Jinks, 1971). The implicit assumption behind such an approach is that the parental population may reasonably be considered as a bivariate normal distribution with non-zero correlation. In this paper we demonstrate that this is not an adequate description of human assortative mating for height, since there is non-linearity and heteroscedasticity in the bivariate distribution; we suggest that these features may be explained by psychological factors, and that genetic models of continuous traits should attempt to take account of such

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factors. In this paper we access human assortative mating by re-analyzing data collected by the National Child Development Study (NCDS) (Butler and Bonham, 1963; Davie et al. 1972; Fogelman, 1976).

Materials and Methods

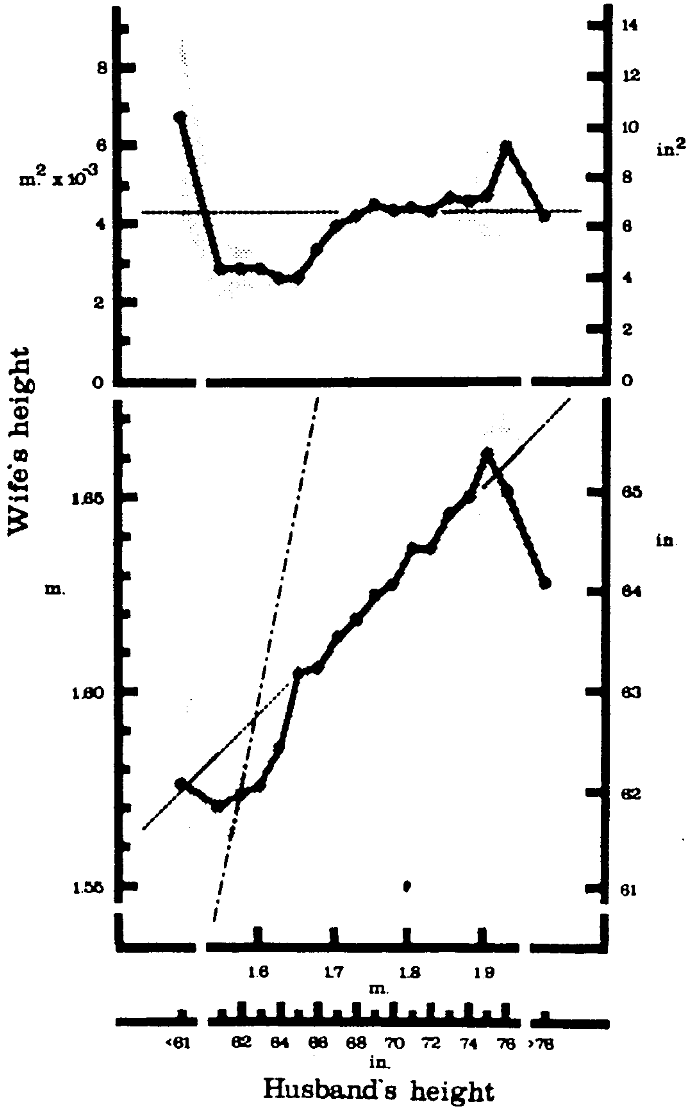
The NCDS commenced as the Perinatal Mortality Survey and involved every child born in the Britain during one week of March, 1958. These children were subsequently followed up at ages 7, 11 and 16. In this analysis we will concern ourselves with the 11 year old follow-up. The mother of each child was asked, amongst a large number of other questions, to give her own height and that of her husband. Since measuremants were recorded in Imperial units to the nearest inch (2.54 cms), and there is evidence in the survey of a moderate degree of even number preference in the reporting of heights (64.6% and 63.2% of mothers' and fathers' heights respectively) we have included metric and imperial units in our figures.

Results and Discussion

The mean and standard deviation of the reported heights are compatible with standard estimates of male and female height (males: mean height = 1.745 meters. SD = 0.075 meters; females: mean height = 1.620 meters, SD = 0.065 meters). A number of the mothers had had their height recorded at the time of delivery by the attending doctor or midwife, some eleven years earlier: the correlation with the reported height when the child was eleven is 0.793 (n = 12,341).

The simple correlation between the height of the mother and the father is 0.2580 (n = 12,994, $p < 0.001$), a value which is comparable with those from many other studies (Spuhler, 1968). Figure 1 shows the mean and the variance of the height of wives of the men in the study, divided according to the husband's height. Figure 2 shows the converse; the mean and variance of the height of husbands, according to the height of their wives. If assortative mating can be considered as a bivariate normal distribution then the mean height of wives should be a linear function of husband's height, and there should be no relationship between variance of wife's height and husband's height; and similarly for husband's height as a function of wife's height.

All points in Figures 1 and 2 are plotted with their respective 95% confidence limits. It can be readily seen, by eye alone, that the rela-



. 1. Shows the wife's height as a function of the husband's height (as given to the nearest inch). The lower portion of the figure shows the mean height of the wife for a particular husband's height (in meters on the left ordinate and inches on the right ordinate) and the upper portion shows the variance of the wife's height for a particular husband's height (in square meters on the left ordinate and square inches on the right ordinate). The shaded areas represent the 95% confidence limits for means and variances. The dashed line (- - - - - - - -) indicates the expected values for a bivariate normal distribution based on the values for husband's height in the range 67 to 74 inches. The dotted and dashed line (-·-·-·-·-) shows the line of equality of height of husband and wife.

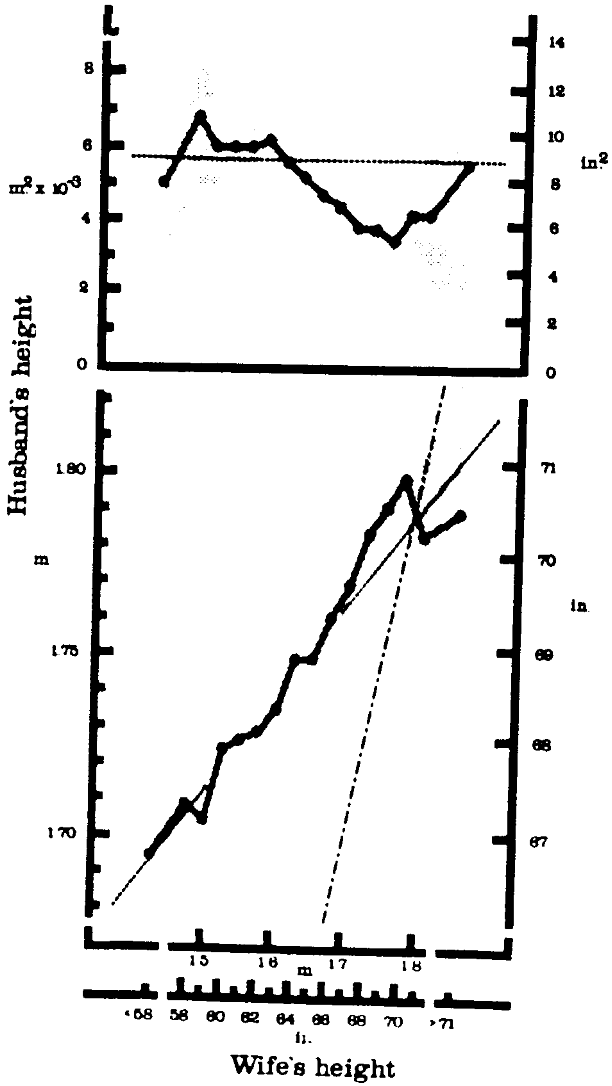


FIG. 2. Shows the husband's height as a function of the wife's height. Conventions as for Figure 1. The expected values are for a bivariate normal distribution based on the values for a wife's height in the range 58 to 65 inches.

tionship between husband's height and wife's height is non-linear (test for non-linearity of mean $p < 0.001$ for Figure 1; $p = 0.0023$ for Figure 2). It may also be readily seen that the variance of wife's height is not independent of husband's height (Figure 1) (Bartlett's test $\chi^2 = 183.23$ 15 df, $p < 0.001$), and the variance of husband's height is not independent of wife's height (Figure 2) ($\chi^2 = 179.65$, 13 df, $p < 0.001$): in both cases the two extreme groups have been omitted from the calculation (since they are not homogenous as their ranges are undefined). In the case of wife's height (Figure 1), there is no significant heteogeneity of variance between husband's heights of 1.55 and 1.65 meters ($\chi^2(4) = 1.97$) or husband's heights of 1.73 and 1.93 meters ($\chi^2(8) = 12.73$). For the husband's height (Figure 2) there is no significant heterogeneity of variance between wife's heights of 1.47 and 1.60 metres ($\chi^2(5) = 4.56$) or wife's heights of 1.70 and 1.80 metres ($\chi^2(4) = 2.50$).

Figures 1 and 2 show the line of equality of height of husband and wife, and this line helps us to explain the effects found. Consider Figure 1. For husband's heights in the range 1.65 to 1.93 meters there is a linear trend of wife's height upon husband's height, and for husband's heights in the range 1.73 to 1.93 meters there is no heterogeneity of variance; these results are what a bivariate normal model of assortative mating would predict. However, over the range of husband's heights from 1.58 to 1.65 meters the wife's height is parallel to the line of equality between husband and wife. There is thus very strong assortative mating over this range, and this is the range over which the variance of wife's height is much reduced; presumably shorter men are selectively marrying women who are shorter than themselves. At the extremes of the range of husband's height (< 1.55; > 1.80 metres) the wife's height is closer to the female mean than the overall regression would predict; presumably at these extremes it is difficult for men to find spouses of "appropriate" height and assortative mating breaks down, and hence the variance in height of these wives is greater than for the rest of the population. Essentially similar reasoning will explain the results of Figure 2. Over the range of wife's height up to 1.68 meters there is linear assortative mating, and up to 1.60 meters there is homogeneity of variance. However as wife's height approaches the line of equality of heights so the husband's height accelerates more rapidly than the simple regression would predict, indicating relatively stronger assortative mating, and confirmed by diminished variance in husband's height. At the extremes of wife's height the husband's variance of height increases, indicating reduced assortative mating, and in the case of women at the upper extreme (> 1.80 meters) this is shown by reduction of husband's height below the expected value, and some evidence for negative assortative mating (i.e. a regression line with a negative slope).

In view of the relatively low correlation between the mother's self report of her own height, and the midwife's assessment of the mother's height (r = 0.798) it might be suspected that the results of the present study are primarily reporting biasses on the part of the mothers, rather than true non-linear assortative mating. However if the study is restricted to the 4591 couples where the midwife's assessment of mother's height and the mother's self report of her height some eleven years later are equal (to the nearest centimeter) then essentially similar results are obtained, suggesting that the results are reflecting true differences in assortative mating. This result is also supported by the observation that the non-linearity of assortative mating is found equally in all social classes, whereas the unreliability of assessment of height is greater in social class V than social class I.

In the present paper it has been shown that assortative mating for height is not simply the result of sampling from a correlated bivariate normal distribution but rather it probably reflects a social expectation, (the "male taller norm", Gillis and Avis, 1980), which results in increased assortative mating as the critical point of height equality is reached, coupled with the limitations imposed by a lack of appropriate persons from whom to select as one approaches either extreme of height, which results in a lessening of assortative mating. There is thus a sense in which assortative mating for height is a "cultural artifact," and hence may well differ between societies. It must be presumed that such differential factors have consequences for genetic models involving socially important factors such as height or intelligence. It should also be pointed out that the present method is unable to determine whether males, females or both are primarily responsible for the selection process, more sophisticated methods being required for that (Eaves and Heath, 1981).

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