Height and reproductive success: a longitudinal study of Finnish twins

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Sexual selection is the driving force behind evolution along with natural selection. Sexual selection refers to a process where some characteristics are preferred in potential mates even when they do not necessarily increase survival probability and thus are not prone to natural selection. The sex which invests more to reproduction, usually females but in some species also males, is assumed to be more selective in mating thus creating more selective pressure to the opposite sex (1).

Although sexual selection has been found to be very common in the animal kingdom (2), including higher primates (3), its role in humans is still controversial. There is good evidence that sexual selection has contributed to sexual dimorphism in body size in primates (4), but it is less clear whether it could explain sex difference in height in humans as well. It was found in a Polish study that short men had higher probability for childlessness as compared to tall men (5). A limitation of this study was, however, that the age of the participants varied from 25 to 60 years, and thus the final achieved number of children was not available for most of the participants. In a British study the number of children showed non-linear association with height in females so that females with average stature had the highest number of children (6). Thus previous studies have given some tentative evidence that tall stature in males and average stature in females is associated with the highest reproductive success.

A problem in these previous studies is that they have not properly adjusted for socio-economic or other covariates which could contribute to this association. It is well known that height is associated with socioeconomic background (7) and socio-economic factors can also affect reproduction in males and females (8). In this study we will analyze this question by using a twin design. Twins are raised in the same family, and identical twins also share their genes. Thus using twin pairs discordant for the number of children allow analyze the role of height behind reproductive outcomes when family background can be regarded as standardized. Further we will analyze whether marital history or education can explain a possible association between height and the number of children.

Data and methods

The data were derived from the older cohort of the Finnish Twin Cohort Study (9). The questionnaires were mailed in 1975 and 1981 to all same-sex Finnish twin pairs born before 1958 and both co-twins alive in 1974. The response rates to these questionnaires were 89% and 84%, respectively. Height, marital status and education classified to eight classes described elsewhere (10) were asked in both questionnaires. Those respondents still studying when reporting their level of education were assumed to have reached the next possible category given in the questionnaire. For height and education we used the questionnaire in 1981 and if it was not available then the questionnaire in 1974 was used. Marital status was classified to currently living or previously lived with a spouse (married, co-habiting, divorced and widowed) in 1981 or in 1974. Self-reported height showed high correlations with measured height in a sub-sample of this same cohort (0.98 in men and 0.96 in women) showing good reliability of self-reporting of height (11). Information on live births is available since the year 1950 in the Finnish population register. This register was updated until June 2009 and linked to the cohorts born 1950-57 in our study sample using unique personal identification number assigned to all Finnish citizens a few days after the birth. Thus the participants were 52-59 years of age at the time of the end of follow-up. In the final study sample, we had 3595 male and 4235 female twin individuals.

We started the analyses by studying the association between the number of children and height at individual level using multinomial logistic regression model. The number of children was divided to three classes: no children (23% in males and 18% in females), 1-2 children (50% and 56%, respectively) and more than 2 children (27% and 26%, respectively). We then adjusted the results for education and marital history. We continued the analyses by studying pair-wise associations in twin pairs discordant for height and childlessness using conditional logistic regression model. Because of possible non-linearity between height and reproduction, we used height divided to sex-specific quintiles and also education was used as a categorized covariate. All analyzes were carried out using the Stata statistical package, version 10.

Results

We started the analyses by studying the odds ratios (OR) with 95% confidence intervals (CI) of having 1-2 and 3 children or more compared to childlessness in height quintiles (the shortest quintile was used as the reference category). In males the highest probability to have

1-2 children was in the third quintile (OR 1.47 95% CI 1.12-1.93), and it decreased slightly when adjusting for education and living with a spouse (OR 1.34 95% CI 1.00-1.81). When analyzing the probability to have 3 children or more the tallest (OR 1.43 95% CI 1.05-1.95) and third quintiles (OR 1.41 95% CI 1.03-1.93) showed the highest probabilities, but these associations were not anymore statistically significant when education and living with a spouse were adjusted for (OR 1.18 95% CI 0.83-1.67 and OR 1.24 95% CI 0.88-1.75, respectively). In women no association was found between height and the number of children.

When analyzing pair-wise associations, the probability to have 1 child or more was highest in the third quintile in males (OR 1.96 95% CI 1.20-3.20) and this association decreased slightly when education and living with a spouse were adjusted for (OR 1.91 95% CI 0.99-3.68). In women no associations were found.

Conclusions

Our results are somewhat contradictory to the hypothesis that tall stature in males would be associated with better reproductive success. We found that in men, but not in women, height is associated with the number of children and this association was found also within twin pairs discordant for height and having children. However in contrast to the hypothesis, reproductive success was highest in men with average stature. This result is in contrast to a previous study of Polish males finding that the association between stature and childlessness is reverse so that shortest men have highest probability to childlessness and this probability decreases steadily to the tallest quartile (5). However in this study the participants were 25-60 years of age, and thus the results may reflect the timing of having children rather than differences in having children over the life course. Furthermore in a study of British women, a reverse U-shaped association between height and number of children was found (6) whereas in our study there was not any clear pattern according to height.

Our study has strengths but also limitations. A major strength of our study is that we had information on a large number of twins which allows optimally take account the family background. Further the study participants were 52-59 years of age at the end of follow-up, and thus we can safely say that our results describe virtually the final number of children also in males. A limitation of our study is that the information of children is register based and

thus paternity cannot be confirmed. It is possible that the results may have been different if real reproductive success would have been taken into account.

To conclude, our results do not support the hypothesis that tall stature is associated with higher reproductive success but rather that average stature may give some advantage for reproduction in males.

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