Fertility rates in Denmark in relation to the sexes of preceding children in the family

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Analysis of the effect of sex combination of previously born children in the family on fertility rates was performed for 363,373 Danish families comprising a total of 613,900 children, to address the questions of sex preference and combination preference. The fertility rates were stratified by parental age, period and latency time to the next child, and fertility rate ratios were estimated using multiplicative Poisson regression models. Our results demonstrate a strong preference for a balanced composition of sexes in Danish families. In families with two or three children the highest fertility rates were seen in families who had same-sexed children. The lowest fertility rates were in families with two children of identical sex followed by a child of the opposite sex. A moderate sex preference for girls was indicated by higher fertility rates in two-boy families than in two-girl families.

Key words: family planning/fertility rates/sex composition/sex preference

Introduction

With the introduction and use of effective contraceptives in many countries, the decision on childbearing and family size is increasingly in the hands of each couple. A preference for having children of one or the other sex, or for particular combinations of sons and daughters, can then affect the decision to have additional children and influence the resulting family size.

Sex preference may be specific for boys or girls, as has been reported from various developing countries (Goody et al., 1981). A preference for one sex could be present, irrespective of the number and sexes of previous children in the family. For example, if the dowry of brides imposes a large economic burden on the family, this could lead to a generally decreased desire for daughters. Such a scenario has been reported in Morocco, India and Bangladesh, where daughters are a financial burden whereas sons contribute to family income (Repetto, 1972). In other situations, sex preference may depend on the sex combination of previous children. For example, with traditional patrilinear inheritance, there may be a strong desire to have at least one son who can inherit the crown, the farm or the business, but the preference for additional sons beyond the first son may be diminishing.

In the latter case, the preference may more adequately be described as a combination preference, i.e. a parental preference for a particular composition of sons and daughters (Loyd and Gray, 1969; Gray, 1972, 1982; Gray and Morrison, 1974; Gray and Morgan, 1976; Medina, 1977; Goody et al., 1981). Combination preference could for example be a desire for a balanced number of boys and girls (Goody et al., 1981). The desire for a balanced family composition has been recognized in several technologically developed countries as an important factor that influences fertility and family size (Loyd and Gray, 1969; Gray, 1972, 1982; Gray and Morrison, 1974; Gray and Morgan, 1976). However, in other studies, no such effect of sex combination has been found (Gray et al., 1980; Birnholz and Farrell, 1987).

Both sex preference and combination preference will lead to a variation in the fertility rate of couples that depends on the sex combination among the previous children in the family. It will also lead to a bias in the composition of completed sibships in the population, with excesses of the most preferred combinations of children. However, unless the probability of conceiving a boy in a given pregnancy depends rather strongly on the number and sexes of the previous children, sex preference and combination preference will have no material influence on the proportion of boys among newborn infants, i.e. on the secondary sex ratio (Yamaguchi, 1989).

Basically, two different categories of methods can be used to measure sex preference and combination preference. Using data on combinations of sexes in completed families, the frequency of different combinations has been used to assess these preferences (Loyd and Gray, 1969; Gray, 1972, 1982; Gray and Morrison, 1974; Gray and Morgan, 1976; Gray et al., 1984). Particularly, if one of the sexes is preferred, persons of the preferred sex will tend to have fewer siblings in completed families (Yamaguchi, 1989), and the preferred sex will tend to be over-represented among the last children in completed families (Gini, 1951). Alternatively, the analysis may be based on measurements of the fertility rate and its dependence on the combination of sexes of previous children in the family. This method has the advantage of allowing for multivariate analysis, taking account of covariates such as parental ages, and it may be applied to data on incomplete families, thus making it possible to investigate more recent data.

The present study describes sex preference and combination preference in the Danish population in the period 1980–1993, using multivariate analysis of fertility rates.
**Materials and methods**

The study population comprised all Danish women who gave birth to their first child in the period 1980–1993. Only live-born children were considered, and women that gave birth to twins or triplets in the period were excluded from analysis. The study population comprised 363,373 women and their 613,900 children of birth order 1–4, born in the period 1980–1993. The data were extracted from the Fertility Database at Statistics Denmark (Knudsen, 1998). For each child information was available on sex, date of birth, maternal and paternal ages at the time of birth of the child.

Fertility rates following first, second and third births were calculated for combinations of sexes in preceding siblings. The fertility rates were stratified by paternal ages at the birth of the previous child, calendar period, and time to the next child. All stratification variables were considered in 5 year groups. A subtraction of 6 months was incorporated in the calculations following a birth, as an attempt to correct for the pregnancy time. The fertility rates were regressed against sex combination of previous children and the stratified variables, using multiplicative Poisson models, and fertility rate ratios and 95% confidence intervals were calculated.

**Results**

The effect of including different combinations of independent factors in the Poisson regression model on the fertility rate is shown in Table I.

Stepwise inclusion of age of father, age of mother, period and latency time in the model altered the effect of sex combination on the fertility rate only marginally except for the factor age of father (Table I). In one-child families, in the model including only the factor sex combination, the fertility rate ratio was 1.02 if the first child was a boy versus 1.00 if the first child was a girl; the difference was statistically significant ($P < 0.001$). However, inclusion of maternal age in the model eliminated this effect entirely. Inclusion of other covariates had no further effect on the estimated parameters.

Figure 1 shows fertility rate ratios as a function of sexes of previously born children, based on the full regression model. In one-child families there was no effect of the sex of the firstborn child on the fertility rate, whereas fertility rates were affected by the combination of boys and girls in two-children and three-children families. In two-children families, the families with a boy (M) and a girl (F) had significantly lower fertility rates than FF families and MM families. The fertility rate was 6% higher in MM families than in FF families ($P < 0.001$).

In three-children families, the highest fertility rates were in the FFF families and MMM families, with no significant difference between the two types of family, and very low fertility rates were seen in MMF and FFM families.

**Discussion**

Our results demonstrate that fertility rates may be used as indicators for sex and combination preference, and show that fertility rates in Denmark (1980–1993) are affected by the sex combination of the preceding children in the family. The strongest effect is seen in the relatively low fertility rates in families with both boys and girls, consistent with a combination preference for a mixture of sexes.

**Sex preference**

In one-child families, the sex of the first born child did not significantly affect the future fertility rate, once paternal age was adjusted for. This indicates that no sex preference is present in one-child families in the Danish population.

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**Table I. Fertility rate ratios for different sex combinations of previous children in the family**

<table>
<thead>
<tr>
<th>Gender combination (no. of families)</th>
<th>Independent variables used in Poisson regression</th>
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<tbody>
<tr>
<td></td>
<td>Gender combination</td>
</tr>
<tr>
<td></td>
<td>Fertility rate ratio (95% CI)</td>
</tr>
<tr>
<td>One-child families</td>
<td>M (186 637)</td>
</tr>
<tr>
<td></td>
<td>F (176 736)</td>
</tr>
<tr>
<td>Two-children families</td>
<td>MM (54 466)</td>
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<tr>
<td></td>
<td>MF (51 131)</td>
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<tr>
<td></td>
<td>FM (50 998)</td>
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<tr>
<td></td>
<td>FF (48 220)</td>
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<tr>
<td>Three-children families</td>
<td>MMM (6012)</td>
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<td></td>
<td>MMF (5864)</td>
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<tr>
<td></td>
<td>MFF (4494)</td>
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<td>FMM (4755)</td>
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<td>FMF (4458)</td>
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<td>FFM (5146)</td>
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<td>FFF (4861)</td>
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</tbody>
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*Reference category.
M = male; F = female.
Sex preference and fertility rates

Figure 1. Fertility rate ratios as a function of sex combinations of children in one-child, two-children and three-children families, with age of parents, period and latency time included as covariates in the Poisson regression model. M represents a male, F a female, and 'a' is the reference group. *P < 0.05, **P < 0.01 and ***P < 0.001. Error bars are 95% confidence intervals.

Opposite has been found in other populations [white American students (Gray, 1982), Korean families (Park, 1978), Nigerian families (Gray et al., 1983) and Libyan families (Al-Rubeai et al., 1984)], where more families stopped having children when the first born was a male, indicating a preference for sons.

The confounding effect of paternal age on the association between sex of the first child and subsequent fertility is consistent with the reported association between paternal age and female biased sex ratio in the offspring (Ruder, 1985; Juntunen et al., 1997).

If any sex preference is to be found in the present data, it would be for females, as indicated by the higher fertility rates in MM families than in FF families. Why should the desire for having a daughter in the MM families be higher than the desire for a son in the FF families? A possible line of speculation is that this sex preference is caused by the desire of women to experience having a child of their own sex, in combination with the decision to have a third child that is often influenced by the woman in the couple. Steinbacher and Gilroy presented evidence suggesting that primiparous, pregnant women prefer a girl slightly more often than a boy (Steinbacher and Gilroy, 1985). Gini cites evidence from Sweden which suggests that there may be some preference of each parent for a child of his/her own sex (Gini, 1951).

If our hypothesis is true in two-child families, then why not in one-child or three-children families? In the one-child family, the main decision is probably of getting a second child or not, with less room for an influence of sex. Similarly, there may be a minority of families who have a desire for a large sibship, and who are less concerned about the sex of the children. Few couples have four children (1.2% of Danish children are fourth or later children) and the fertility rates in three-children families are estimated with less precision, as is seen in the width of the confidence intervals in Figure 1.

Other explanations than sex preference may be postulated for the higher fertility rate in MM families than FF families. Coital rate is associated with fecundability, and coital rate seems to be associated with a high sex ratio (James, 1997). Hence, the additional fertility in MM families could in part be due to higher coital rate in combination with inefficient contraception. However, the additional fertility in MM families was totally robust to statistical adjustment for parental ages (which presumably has some association with coital rate) and it is therefore not likely that coital rate is a major cause of the observed difference (Table I). Another hypothetical confounder could be parental testosterone levels, which are possibly associated with a high sex ratio (James, 1996) and with risk-taking (sensation-seeking) behaviour (Daitzman and Zuckerman, 1980). Both of these explanations, if real, would presuppose the existence of sib–sib correlation with respect to sex, which actually seems to be negligible in the Danish population. Among all children born 1980–1993 we have observed no biologically or statistically significant association between the sex of a child and the sex of the preceding child (‘Markov variation’) or the sexes of the preceding children in the family (‘Lexis variation’); also, there was no association between sex of a child and maternal parity (‘Poisson variation’), once paternal age was adjusted for (R.Jacobsen et al., unpublished data; a tabulation is available on request).

Combination preference

The combination of sexes of previous children affects fertility rates materially. The low fertility rate in families with a mixture of sexes, and the high fertility rate in families with children of the same sex, suggest a preference for mixed sibships. This is in accordance with most studies from technologically developed countries (Gray, 1972, 1982; Gray and Morrison, 1974; Gray and Morgan, 1976; Medina, 1977; Goody et al., 1981), but not with studies from less developed countries (Gray and Bortolozzi, 1977). It is particularly interesting to note that the very high fertility in MM and FF families actually turns into a very low fertility rate in MMF and FFM families, i.e. after the birth of a child of the missing sex. This
The use of fertility rates to measure preference for specific sex combinations seems to have some advantages in comparison with methods using data on completed families (i.e. Gini, 1951; Gray and Morrison, 1974; Medina, 1977; Gray and Bortolozzi, 1977; Gray et al., 1980; Crouchley and Pickles, 1984; Birnholz and Farrell, 1987; Yamaguchi, 1989). The use of the multivariate model makes it possible to adjust for other factors than the sex combination, such as parental age, period, and time since previous birth, all of which may influence fertility rates. Further, the method compares rates rather than numbers, which removes the effect of the slightly skewed secondary sex ratio: more males than females are born, and therefore more children are born subsequent to a boy than to a girl. Finally, this method is not dependent on the assumption of completed families, which has the consequence that more recent data can be investigated.

References


Received on September 1, 1998; accepted on December 18, 1998