

*Short Report***Daughters Increase Longevity of Fathers, But Daughters and Sons Equally Reduce Longevity of Mothers**GRAZYNA JASIENSKA,^{1*} ILONA NENKO,¹ AND MICHAL JASIENSKI²¹*Department of Epidemiology and Population Studies, Jagiellonian University, 31-531 Krakow, Poland*²*Nowy Sacz Business School-National-Louis University, 33-300 Nowy Sacz, Poland*

ABSTRACT Reproduction is energetically and physiologically expensive, and an individual investing resources into producing offspring should suffer costs such as deterioration in health condition and possibly shorter life span. Since the energetic and nutritional demands of pregnancy and breastfeeding render reproductive costs much higher in women than in men, women with a large number of children should show signs of deterioration in condition, while men with large families should not. However, whether reproductive costs reduce longevity in women is still questionable, and in men this issue has not been adequately addressed. In addition, since sons are energetically more expensive to produce than daughters, having sons should have a more pronounced negative impact on maternal longevity than having daughters. Here we document a striking disparity in the impact of children on the life span of mothers and fathers in a Polish rural population. We show for the first time that number of daughters was positively related to a longer life span of their fathers, increasing their longevity on average by 74 weeks per daughter born, while number of sons did not have a significant effect on paternal longevity. In contrast, in women, the number of daughters and number of sons reduced maternal longevity and did so to the same extent, on average by 95 weeks per son or daughter, indicating that for women, the costs of having sons and daughters are similar. *Am. J. Hum. Biol.* 18:422–425, 2006. © 2006 Wiley-Liss, Inc.

Reproduction is energetically and physiologically expensive, and an individual investing resources into producing offspring should suffer costs such as deterioration in health condition and possibly shorter life span. Since energetic and nutritional demands of pregnancy and breastfeeding render reproductive costs much higher in women than in men, women with a large number of children should show signs of deterioration in condition, while men with large families should not. However, whether reproductive costs reduce longevity in women is still questionable (Lycett et al., 2000; Beise and Volland, 2002; Helle et al., 2002; Muller et al., 2002; Doblhammer and Oeppen, 2003; Van de Putte et al., 2003), and only a few studies addressed this issue in men (Helle et al., 2002; Doblhammer and Oeppen, 2003), documenting a lack of significant effect of children on paternal longevity.

Our study tested whether number of children had an impact on the life span of mothers and fathers. In addition, since sons are energetically more expensive to produce than daughters, we tested whether having sons had a more pronounced negative impact on maternal lon-

gevity than having daughters. Here we document a striking disparity in the impact of children on the life spans of mothers and fathers. We show for the first time that number of daughters was positively related to longer life span of their fathers, while number of sons did not have a significant effect on paternal longevity. In contrast, in women, the number of daughters and number of sons reduced maternal longevity and did so to the same extent, indicating that the costs of having sons and daughters are similar.

MATERIALS AND METHODS

We collected demographic data from church records on 4,310 people (2,147 women and 2,163

Grant sponsor: Center for Human and Primate Reproductive Ecology.

*Correspondence to: Grazyna Jasienska, now at the Radcliffe Institute for Advanced Study, Harvard University, 34 Concord Ave., Cambridge, MA 02138.
E-mail: jasienska@post.harvard.edu

Received 30 March 2005; Revision received 3 November 2005; Accepted 11 November 2005

Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/ajhb.20497

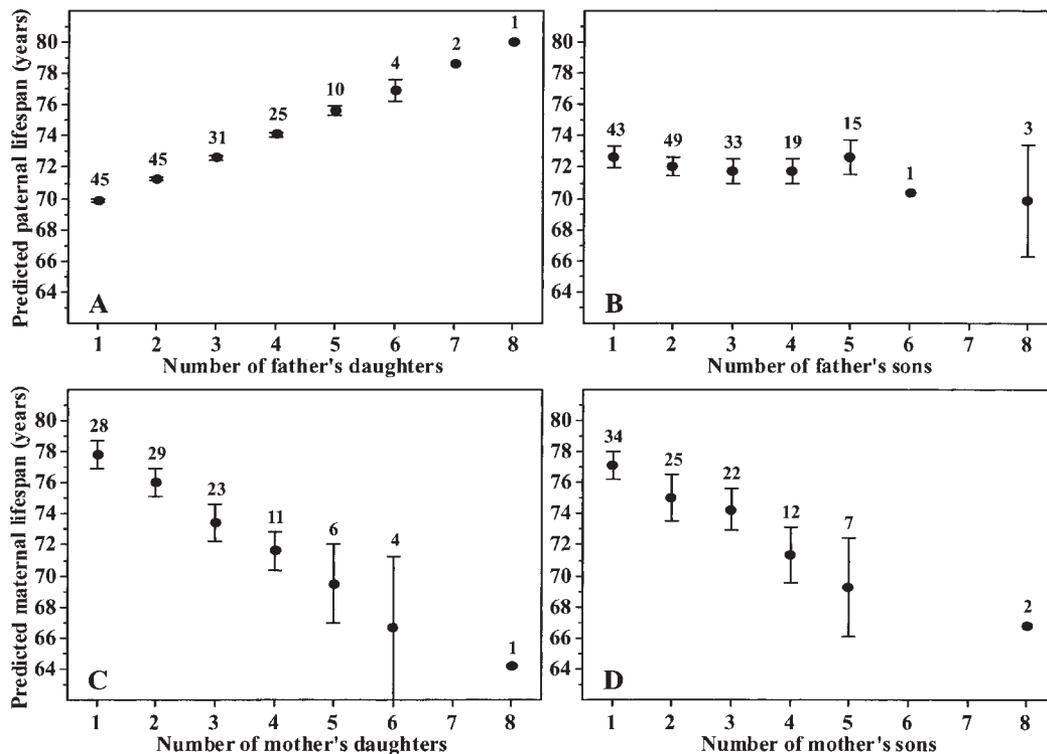


Fig. 1. Longevity of Polish men (A and B, $n = 163$) and women (C and D, $n = 102$) with respect to number and gender of offspring born. Plots represent expected paternal and maternal life spans as predicted by multiple-regression models. Points are means (computed from values predicted for individual men and women), shown with 95% confidence intervals. Bars were removed for clarity when $n = 2$. Numbers above symbols represent numbers of observations.

men) born between the years 1886–2002 in four neighboring villages in southern Poland (Mogielica Human Ecology Study Site, Jasienska and Ellison, 2004). For the analyses, we used data from 102 women and 163 men who had died by the time of data collection and had at least one son and at least one daughter. This sample did not include people who were single, were married more than once, or died before age 45. Women had 5.0 (standard error, $SE = 0.21$) and men had 5.2 ($SE = 0.17$) children on average.

The impact of number of children on maternal and paternal life spans was analyzed in two separate multiple-regression analyses. The simultaneous impact of the number of daughters and the number of sons on maternal life span was analyzed in a first-order regression model, with numbers of daughters and sons as two independent variables. A similar model was used to analyze the relation-

ship between numbers of daughters and sons and paternal life span. Preliminary analyses (using the package JMP 5.0 for Macintosh) showed that the second-order terms were not significant (maternal data, $F_{3,96} = 0.576$; paternal data, $F_{3,157} = 0.368$). Interactions among independent variables were responsible for a nonsignificant fraction of the second-order sum of squares (maternal data, 0.2%; paternal data, 44.7%). Consequently, the second-order terms were dropped, and the regressions were analyzed as first-order models.

RESULTS

In men, neither the total number of children (regression coefficient $b = 0.59$, $SE = 0.41$, $t = 1.44$, $P = 0.15$) nor number of sons (nonstandardized partial regression coefficient $b = -0.255$, $SE = 0.586$, $t = 0.44$, $P = 0.664$; Fig. 1B) was

related to paternal longevity. However, the number of daughters significantly increased longevity of their fathers, on average, by 74 weeks per each daughter born ($b = 1.43$, $SE = 0.585$, $t = 2.45$, $P = 0.015$; Fig. 1A).

In contrast, the total number of children had a strong negative effect on maternal longevity ($b = -1.28$, $SE = 0.48$, $t = -3.79$, $P = 0.003$). More specifically, maternal longevity was negatively affected both by the number of daughters ($b = -2.04$, $SE = 0.705$, $t = 2.90$, $P = 0.005$; Fig. 1C) and by the number of sons ($b = -1.61$, $SE = 0.702$, $t = 2.29$, $P = 0.024$; Fig. 1D). However, the negative impact on maternal longevity of the number of children born to a mother was not related to the children's gender: sons and daughters affected maternal life span to the same degree (comparison of nonstandardized partial regression coefficients, $F_{1,99} = 0.185$, $P = 0.67$, Fig. 1C,D), reducing it, on average, by 95 weeks per son or daughter.

A correlation between the longevity of husbands and wives was not detectable in this population ($n = 75$, $R = 0.055$, $P = 0.64$). However, since other studies investigating relationships between number of children and maternal longevity controlled for the husband's age at death, we analyzed a multiple-regression model with number of daughters, number of sons, and husband's age at death as independent variables. The effects of number of daughters and number of sons on maternal longevity remained significant ($P = 0.0006$ and $P = 0.0035$, respectively), and the effect of husband's age at death was not significant ($P = 0.19$).

The maternal year of birth (of mothers born between 1894–1937) did not have a significant correlation with the number of daughters ($R^2 = 0.014$, $P = 0.23$) or number of sons ($R^2 = 0.035$, $P = 0.06$), which shows that our results were not confounded by a potential secular trend in fertility. Further, in order to control for a potential nonlinearity of the secular trend, we performed an analysis of variance (ANOVA), with women divided into four cohorts according to year of birth: there were three 11-year cohorts and a final 12-year cohort. The mean number of children in cohorts was 5.0 for the maternal cohort born between 1894–1904, 4.5 for the 1905–1914 cohort, 5.7 for the 1915–1924 cohort, and 5.9 for the cohort born between 1925–1937. There was no significant variation among cohorts in mean number of children ($F_{3,98} = 2.56$, $P = 0.06$), with all pairwise differences among cohorts being statistically insignificant (Tukey-Kramer post hoc tests).

DISCUSSION

The Polish rural community has a traditional, paternalistic model of family structure. Since daughters traditionally help with household tasks, men who have more daughters are likely to be better nourished and to live in more hygienic conditions than men who have fewer daughters. Men who have families have lower levels of testosterone (Gray et al., 2002). Testosterone is an immunosuppressor, and high levels of this hormone may be detrimental to health and survival. It remains to be established if the gender of children affects the testosterone levels of their father, but having more sons in a family may increase the level of male competition. In families with more daughters there is also a higher probability that one of the daughters will not marry and will remain at home to help her parents.

Although domestic help seems important to fathers' well-being, it is evident that help provided by children does not compensate for physiological and energetic costs borne by mothers with high reproductive outputs. A shorter life span of mothers may result from depletion of the maternal organism due to the costs of reproduction (Tracer, 1991; Little et al., 1992; Christensen et al., 1998). This view is supported by our preliminary results suggesting that number of children negatively affects maternal health conditions in contemporary, post-reproductive women ($n = 31$; mean number of children, 5.6) living in the same region. Those who had more children had a significantly lower body fat percentage and a higher number of medically diagnosed health problems.

Our results do not support the hypothesis that having sons, who are energetically more expensive than daughters, should have a more negative impact on maternal condition. Higher physiological costs resulting from having sons may be related to their faster rate of intrauterine growth and heavier average weight at birth (Marsal et al., 1996; Loos et al., 2001). In Finnish Sami (Helle et al., 2002) and in a Flemish village (Van de Putte et al., 2003), the number of sons born was shown to reduce maternal life span, while the number of daughters did not. However, the difference in energetic costs of having a son relative to the costs of having a daughter is very small in comparison to the costs of an additional reproductive event, regardless of the child's gender. In addition, there is evidence that mothers who are in better nutritional condition are more likely to produce

sons than daughters (Gibson and Mace, 2003), and it is likely that such women can afford the additional costs associated with having male offspring.

The high cumulative costs of reproduction may be especially detrimental for women in poor energetic condition, e.g., when low-quality food is combined with intense physical work. The economic status of the studied agricultural population in Poland was relatively low. Families own small, scattered, poor-soil fields on slopes of mountains, and women face high energetic demands of physical labor, as indicated by the documented work-related reproductive suppression (Jasienska and Ellison, 1998, 2004). Conflicting results of studies documenting reproductive costs on parental longevity may therefore result from differences in the ecological, social, and economic conditions of study populations.

ACKNOWLEDGMENTS

We are grateful to Rev. Jozef Puchala (Jurkow Parish, Poland) who kindly granted access to demographic records. We also thank an anonymous reviewer for constructive comments which improved our statistical analyses.

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